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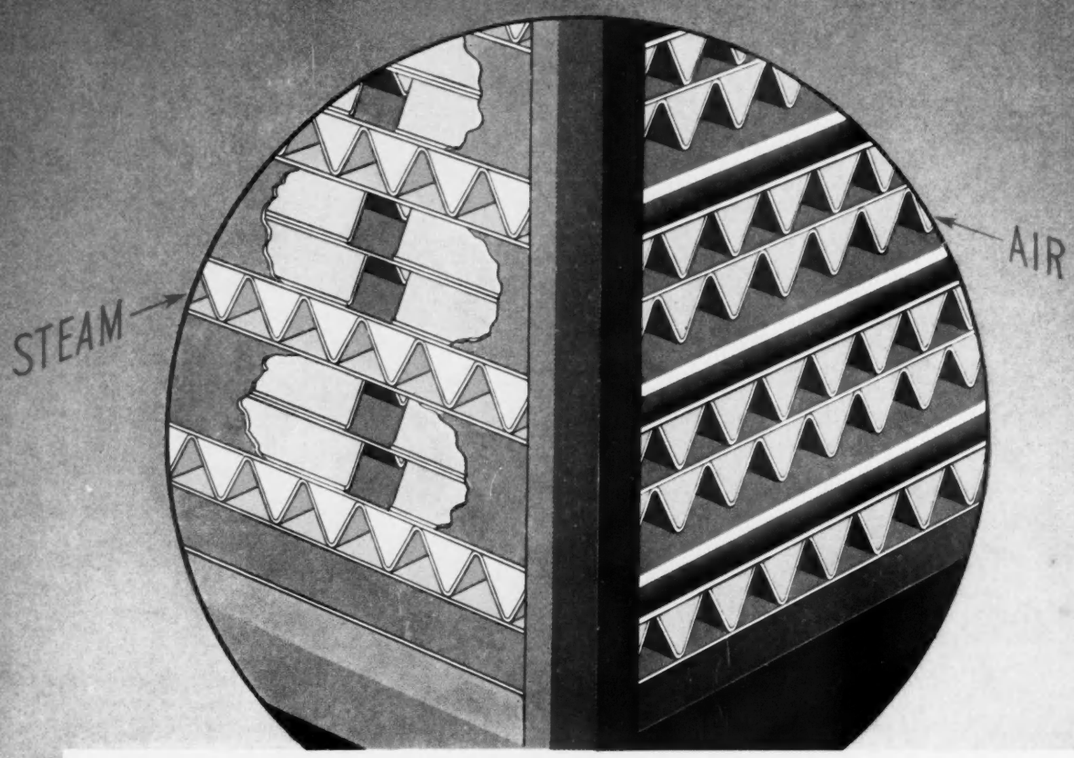

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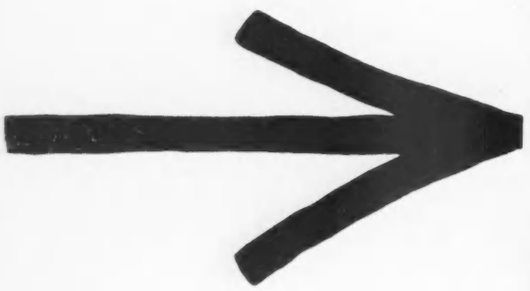

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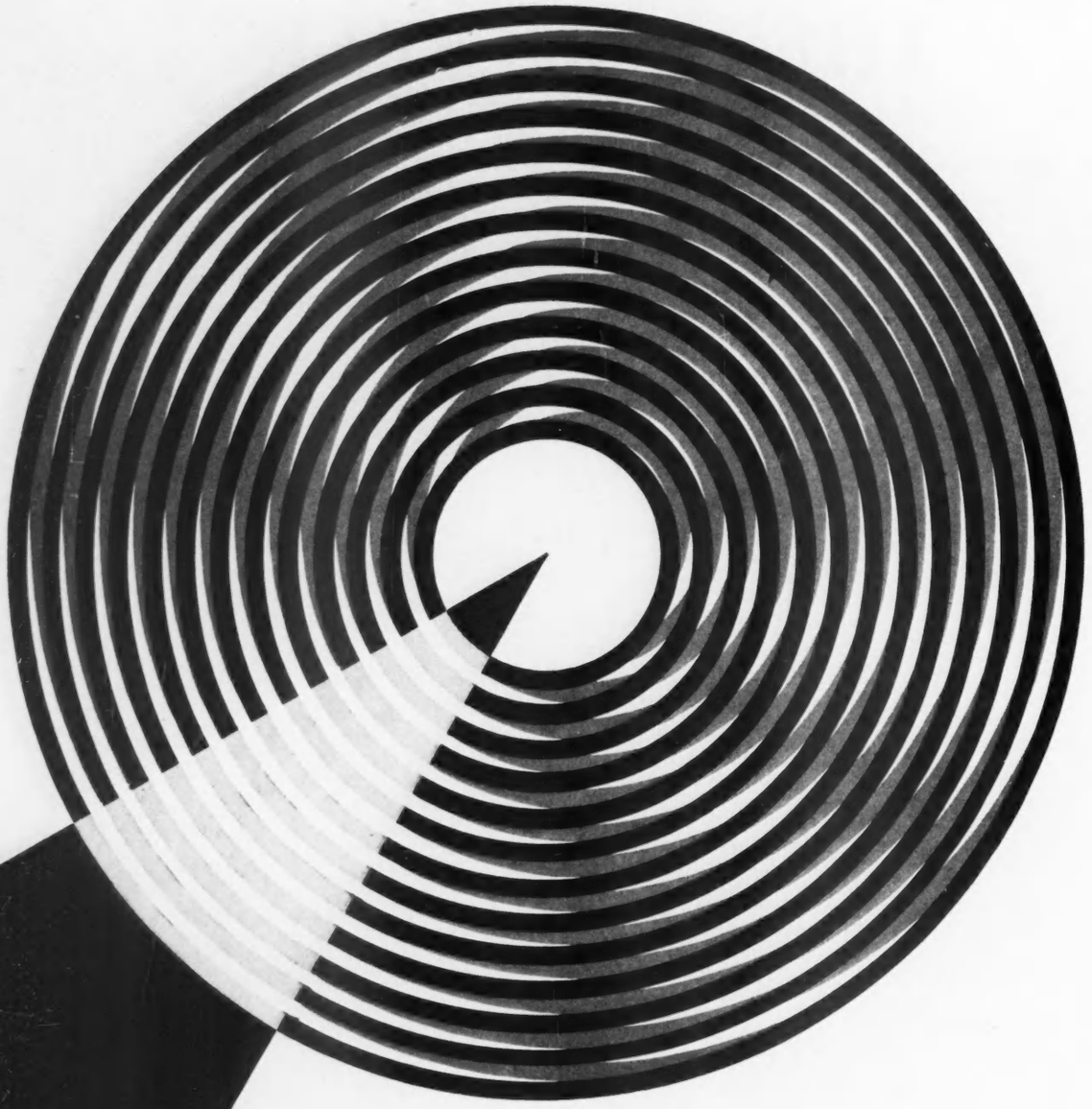

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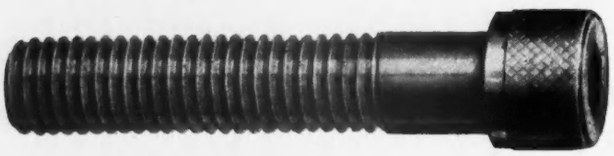

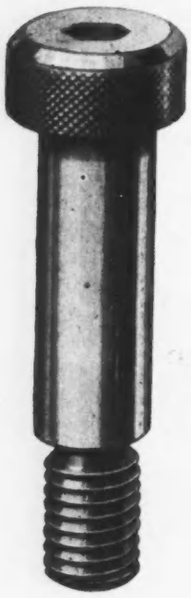

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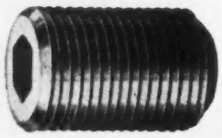

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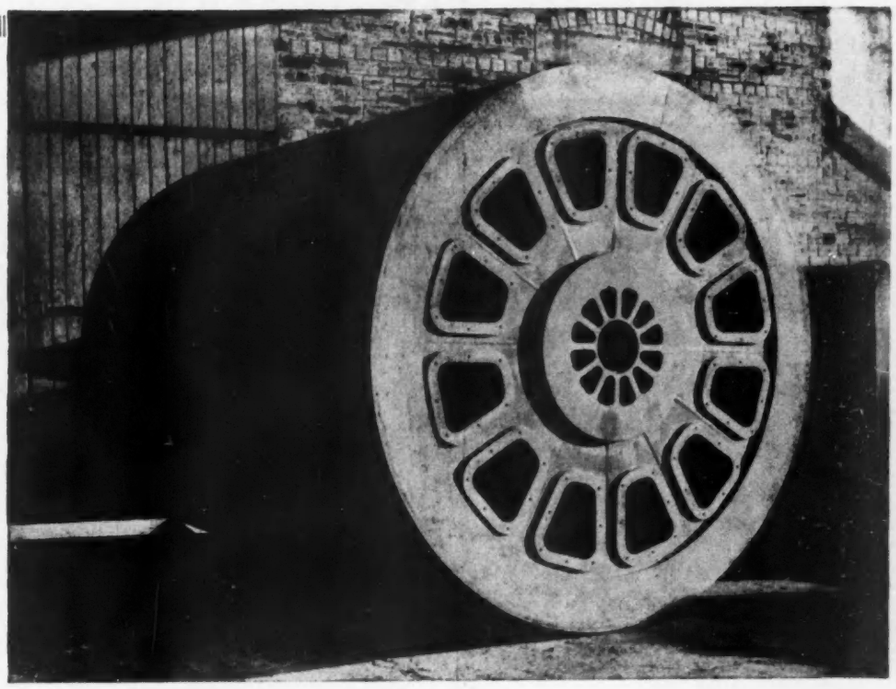

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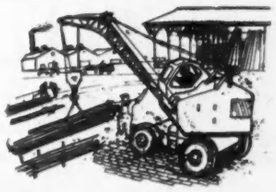

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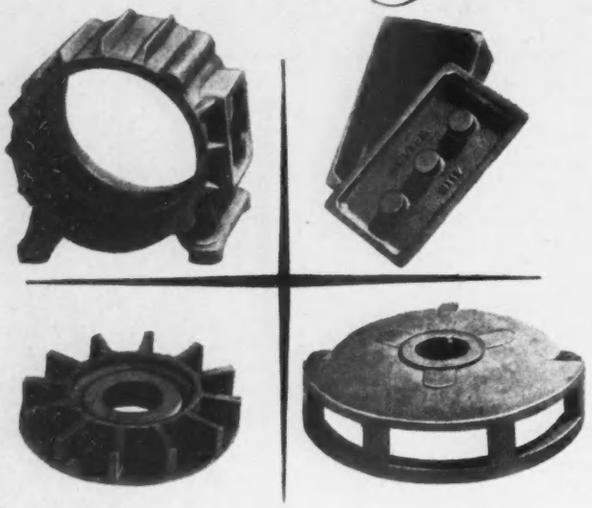

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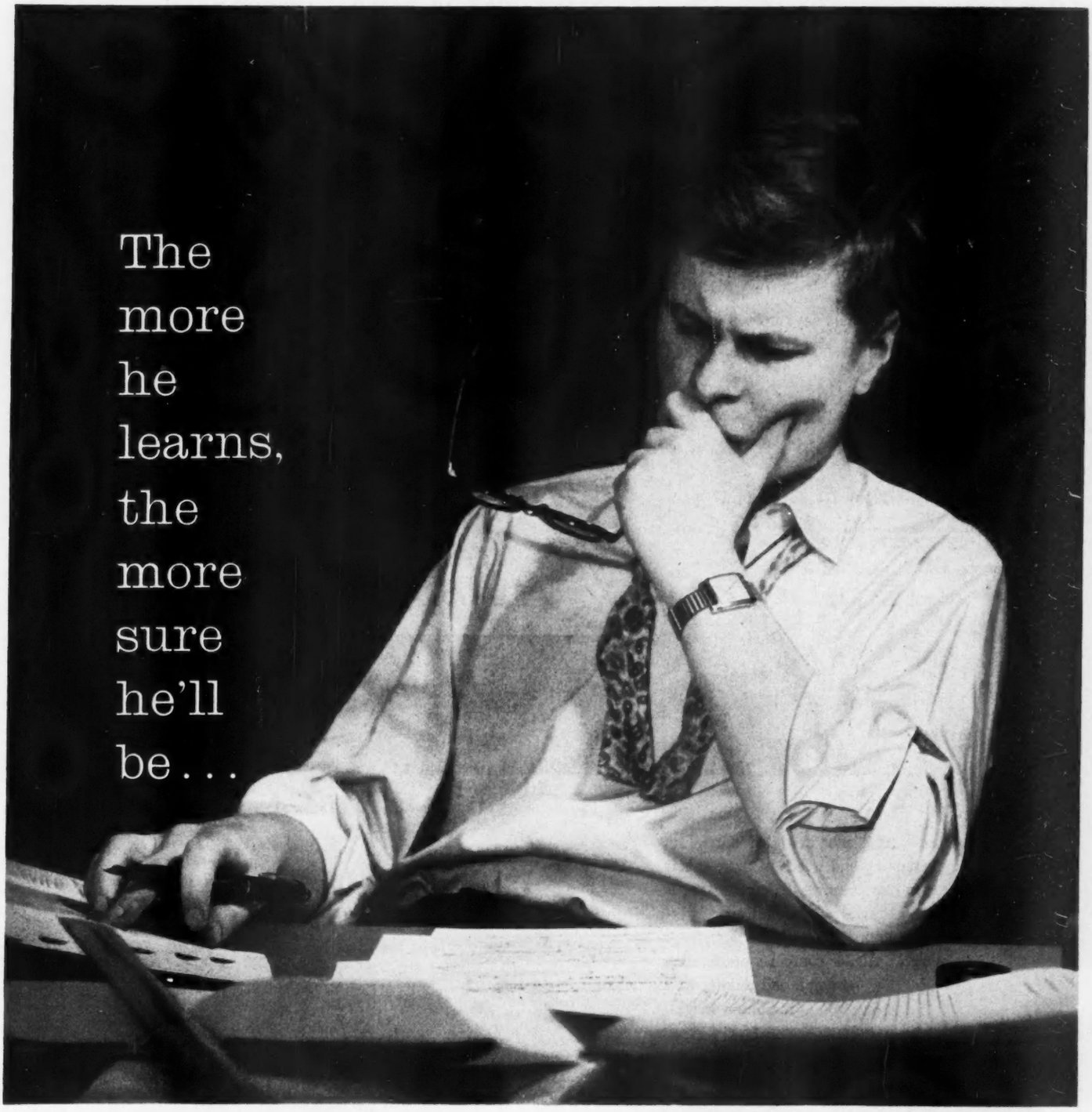

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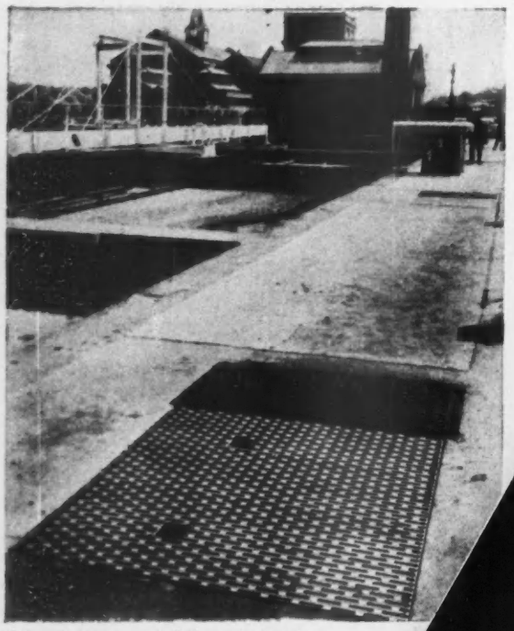

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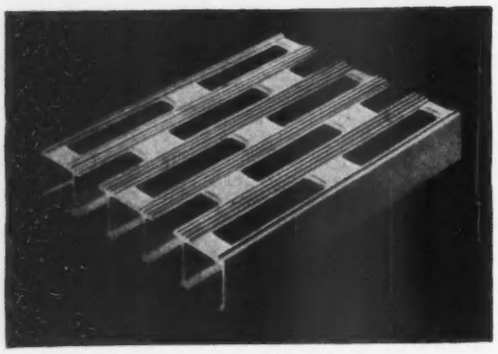

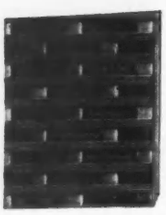

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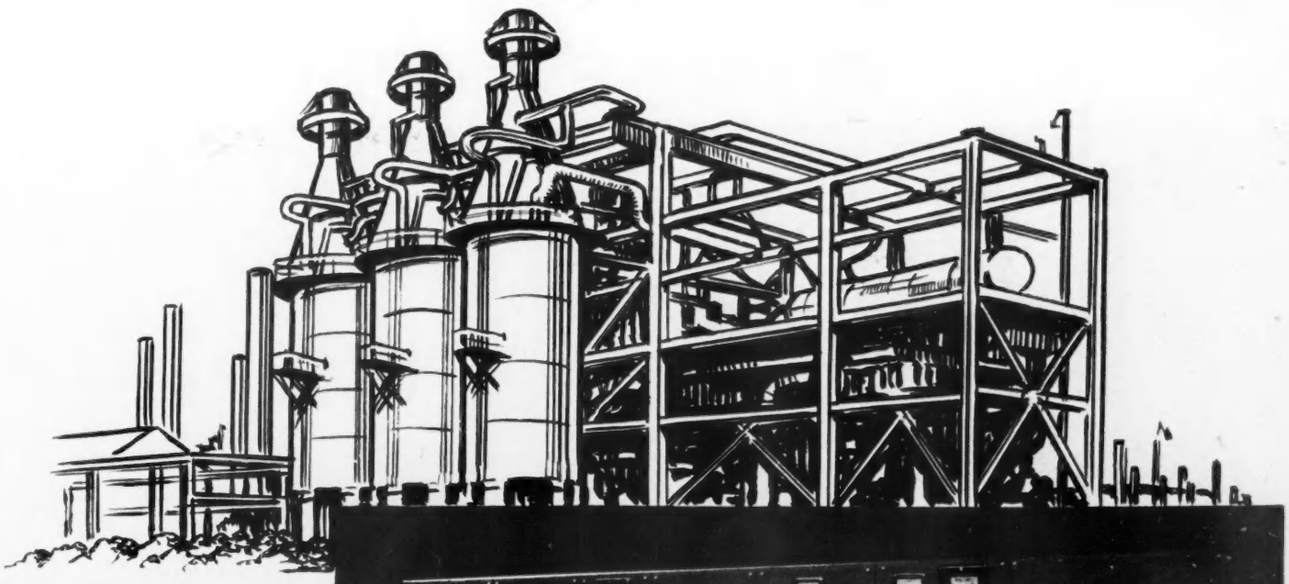

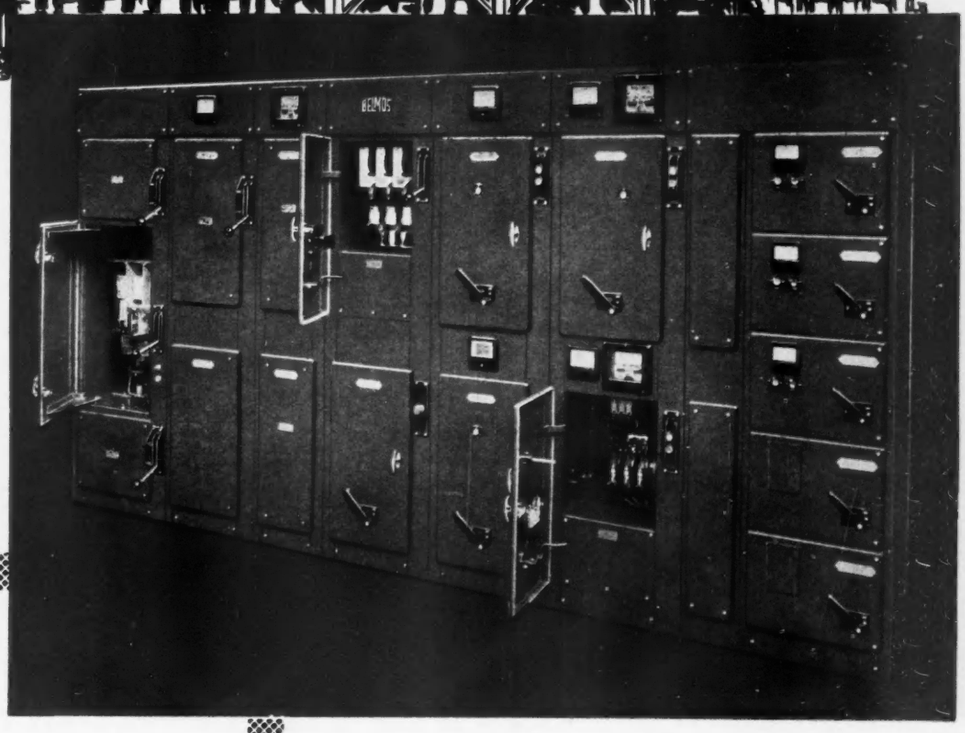

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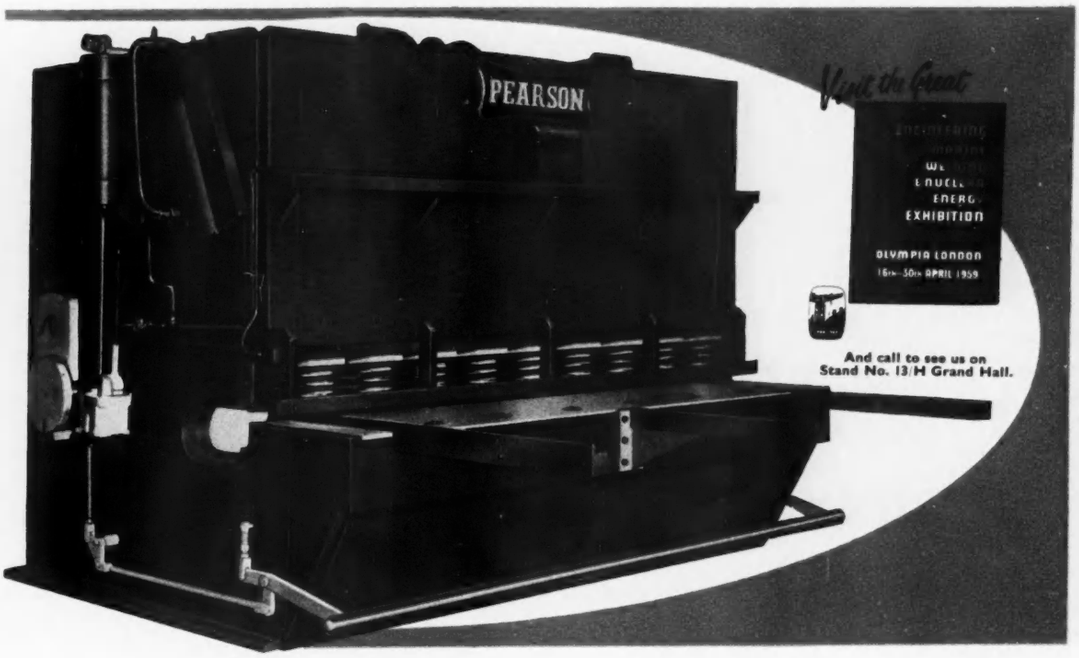

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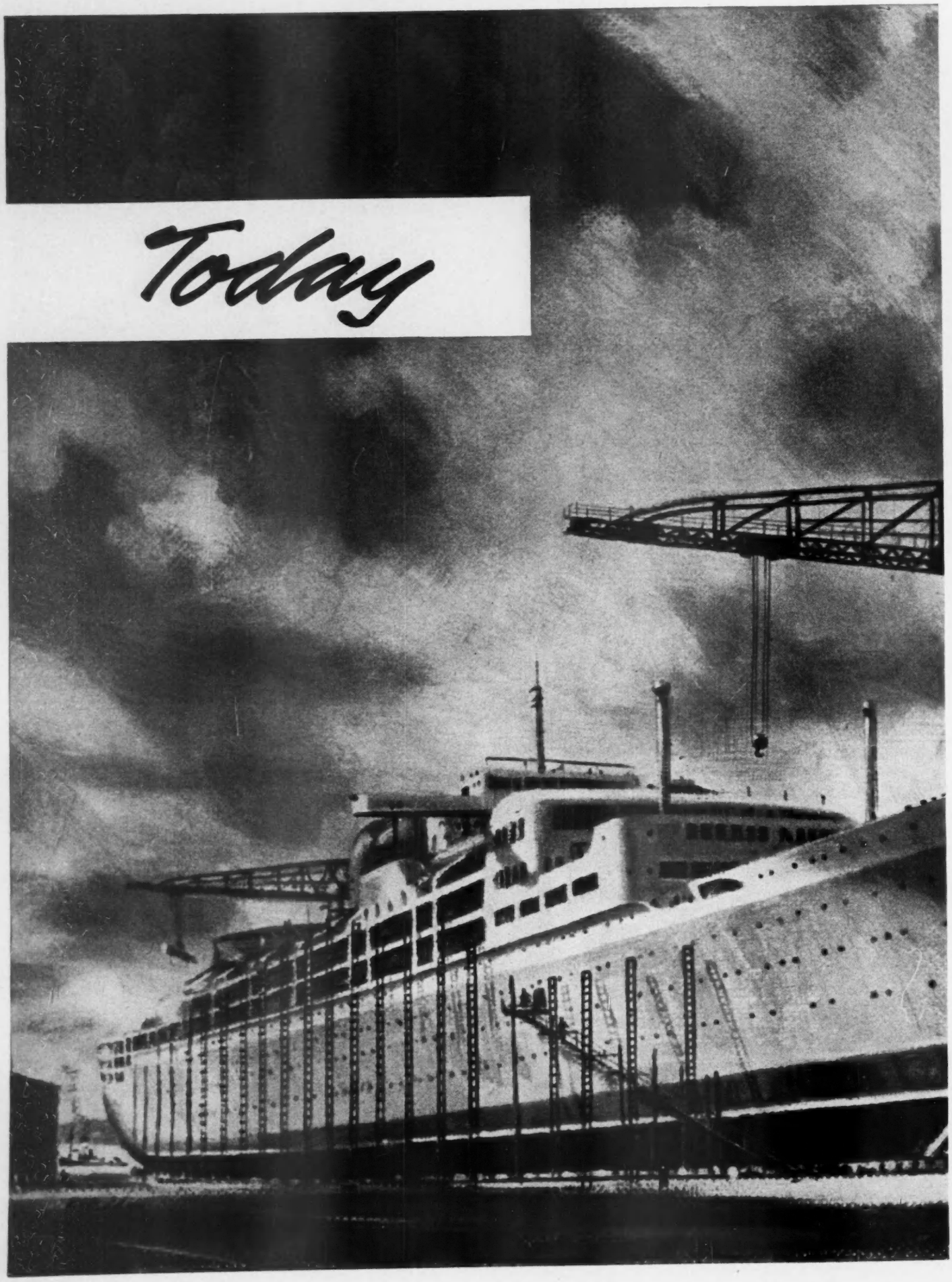
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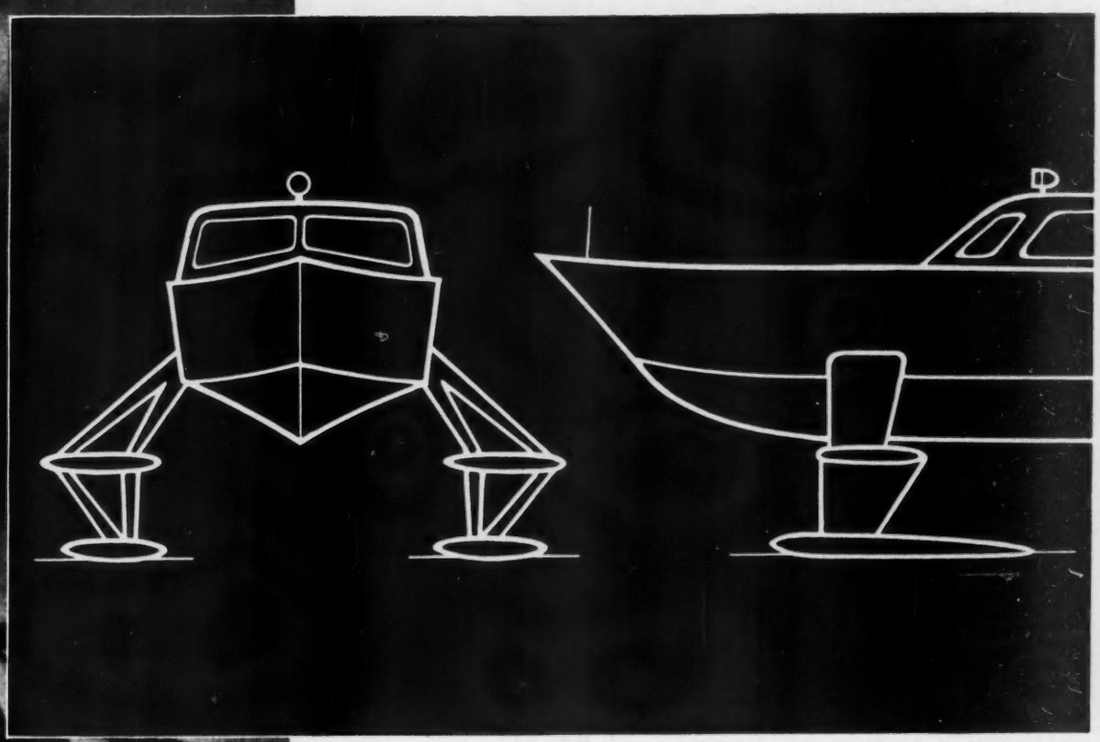

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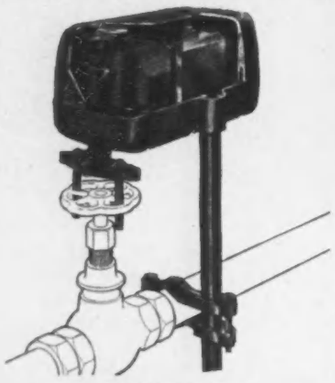

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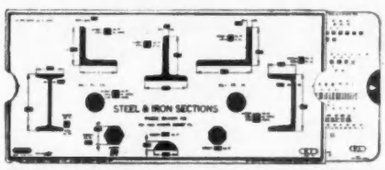

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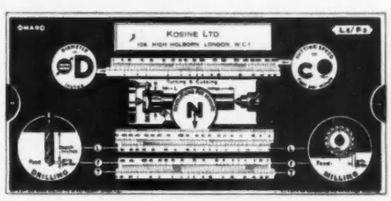

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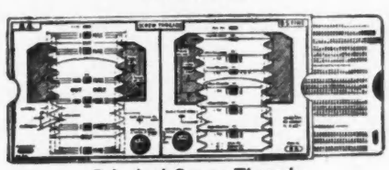
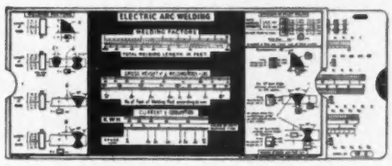


Principal Screw Threads
(a) British Standard Whitworth (B.S.W.)
(b) British Standard Pipe (B.S. Pipe)
(c) British Standard Fine (B.S.F.)
(d) British Association (B.A.)

Standard Quality (glazed)... ... 6/3 post free.

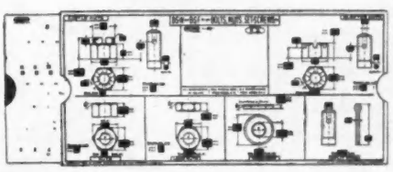
Model W. 2



Electric Arc Welding

Side 1, as illustrated. Scales giving quantities of welding rods used and current consumption according to size, type and total length of welds. Side 2, Particulars relating to fillet and butt welds.
Standard Quality (glazed)... ... 7/- post free.

Model S. 3

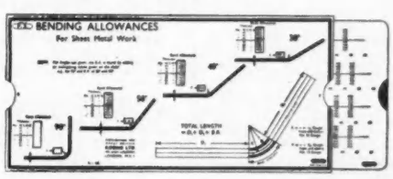


Side 1
Full particulars of B.S.W. and B.S.F. bolts and nuts, including Castle-nuts, Slotted-nuts, Lock-nuts, Washers and Split-pins.
Standard Quality (glazed)... ... 5/3 post free.

In Production

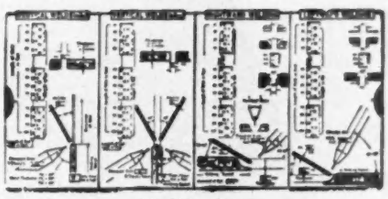
Model S.7. Side 1—thread data for UNF and UNC threads. Side 2—tensile strength and dimensions of UN bolts, normal and heavy series, dimensions of nuts and lock-nuts.

Model P. 2



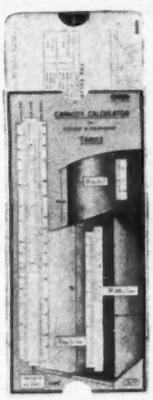
Side 2
Bending Allowances for sheet metal work according to the values of the Bending Angle, the Radius and the Thickness of the Metal Sheets.
Standard Quality (glazed)... ... 7/- post free.

Model W. 1



Side 2 : **Welding Data**
Rightward and Leftward Welding, Vertical Welding (from one side, one welder and simultaneously from both sides, two welders). Blowpipe sizes (in cubic feet Acetylene per hour). Types of joints recommended, Distances between edges. Welding Rod sizes, Welding Rod consumption in feet and corresponding weights, for weld-lengths of 10 to 100 feet. Welding Time per foot and Welding Speed per hour. All values related to various thicknesses of mild steel.
Standard Quality (glazed) ... ... 6/3 post free.

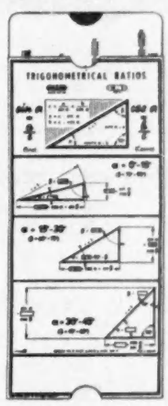
Model L. 11



Capacity Calculator for rectangular and cylindrical Tanks and Containers. Capacity Scales 10-1,000 cu. ft., and 65-6,000 gallons.

Side 1 :
Weights and capacities of buttwelded, mild steel, cylindrical, dished-end Tanks.
Standard Quality (glazed) 7/- post free.

Model M. 1



Trigonometrical Functions
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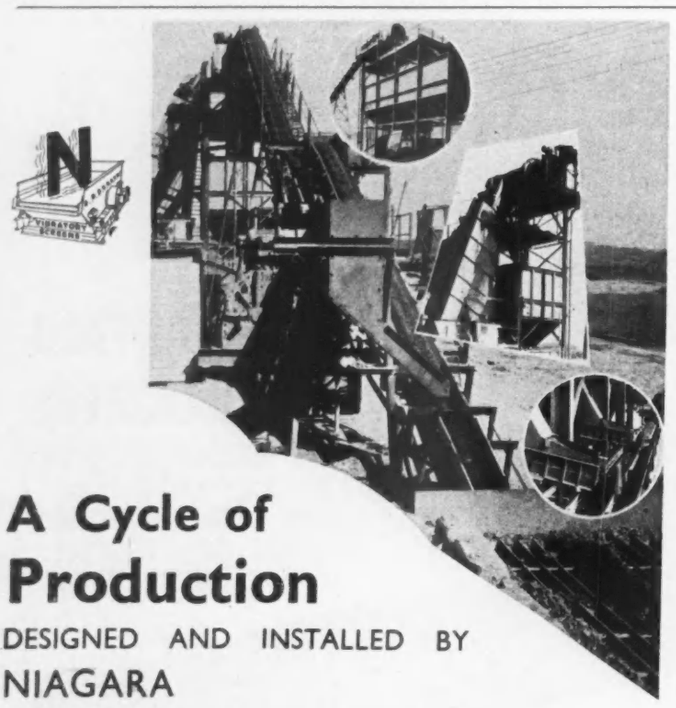

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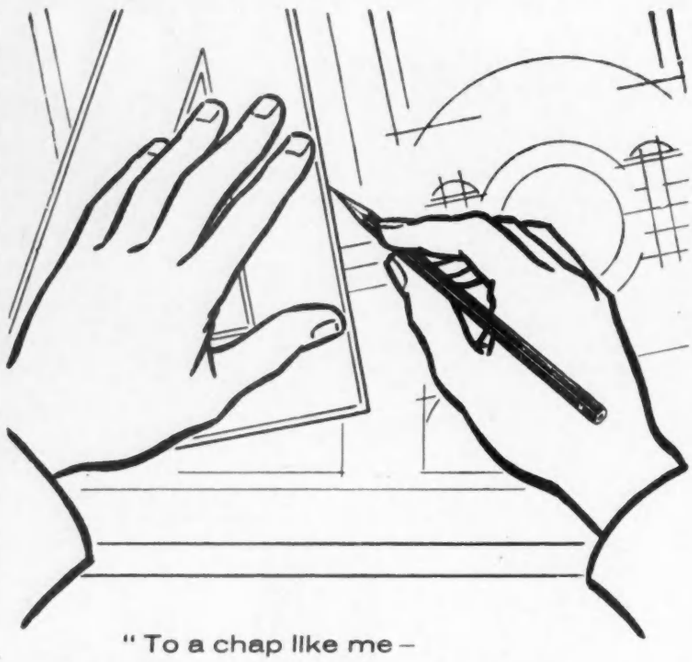

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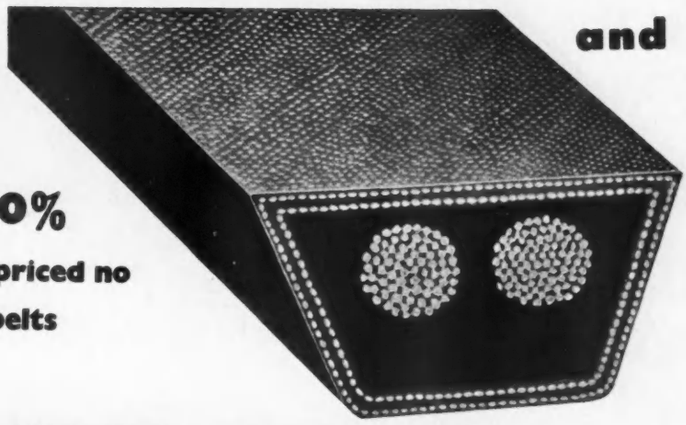
between this  and any other V-belt

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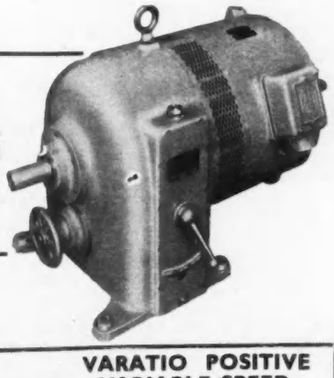

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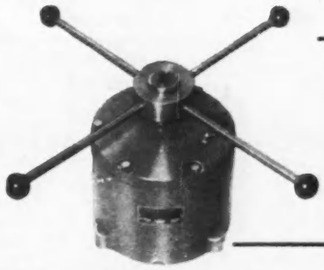

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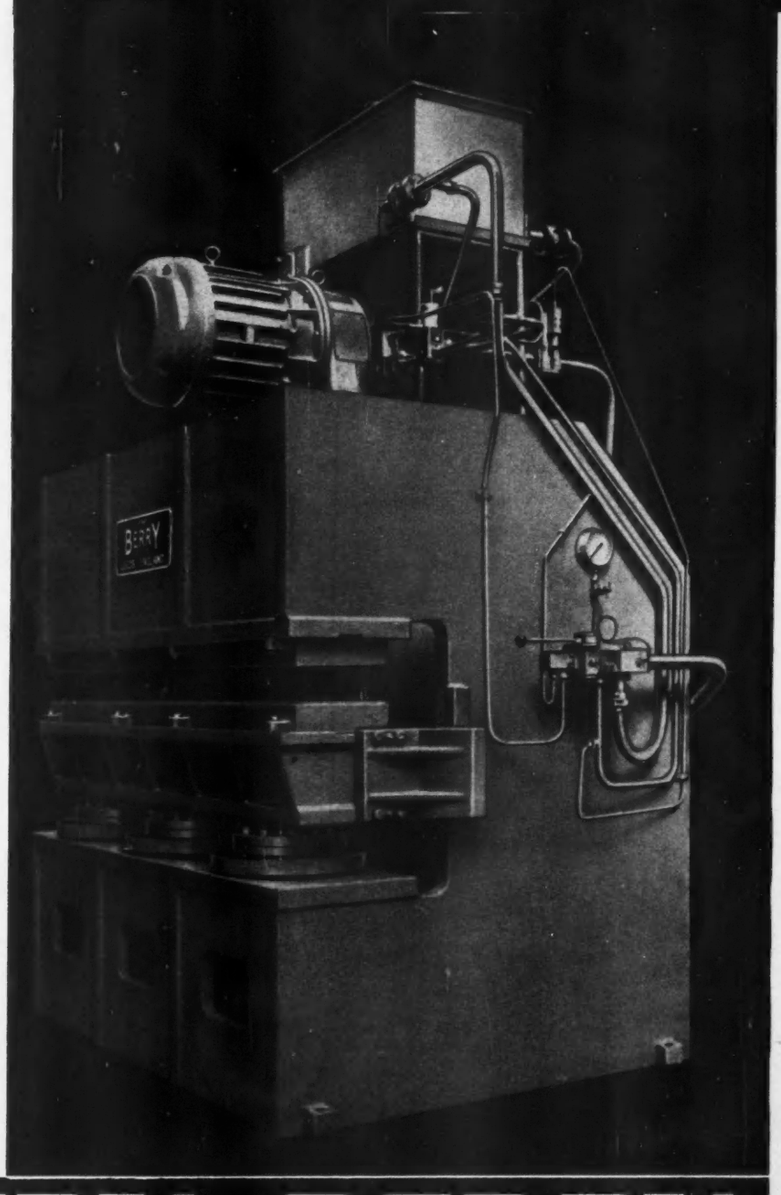

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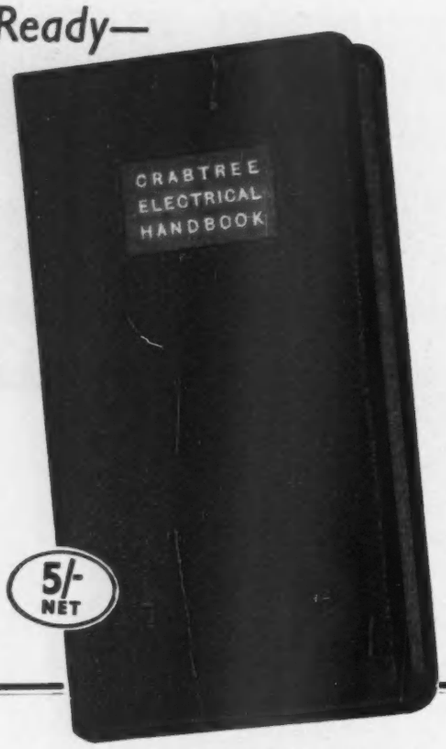

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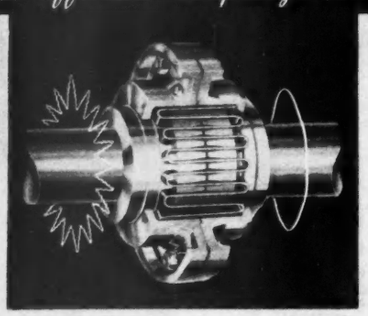

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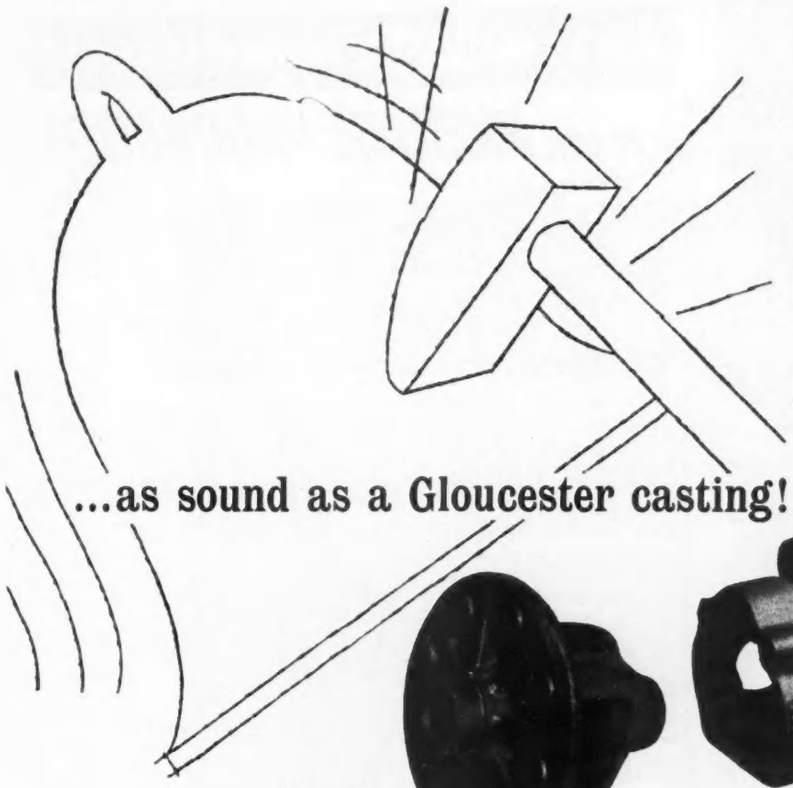

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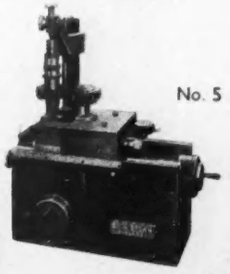

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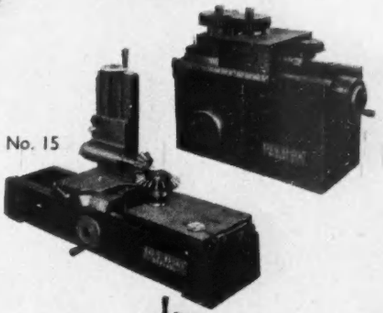

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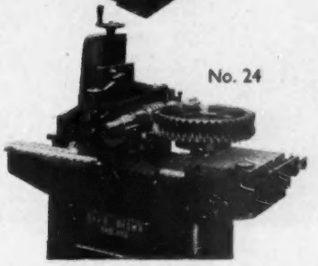

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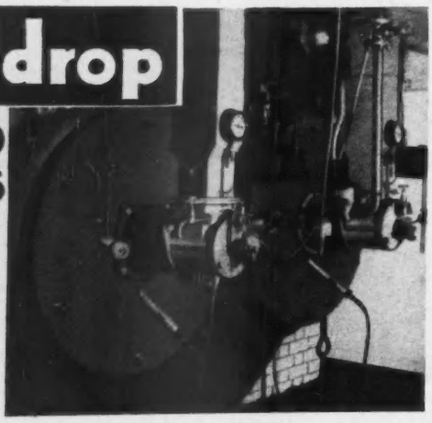

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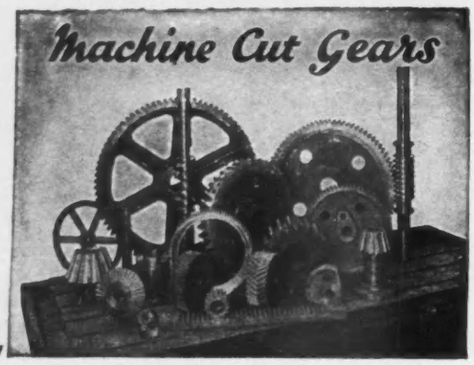

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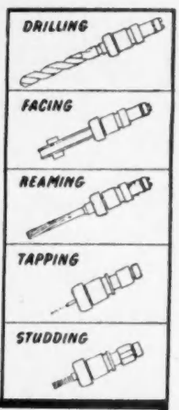

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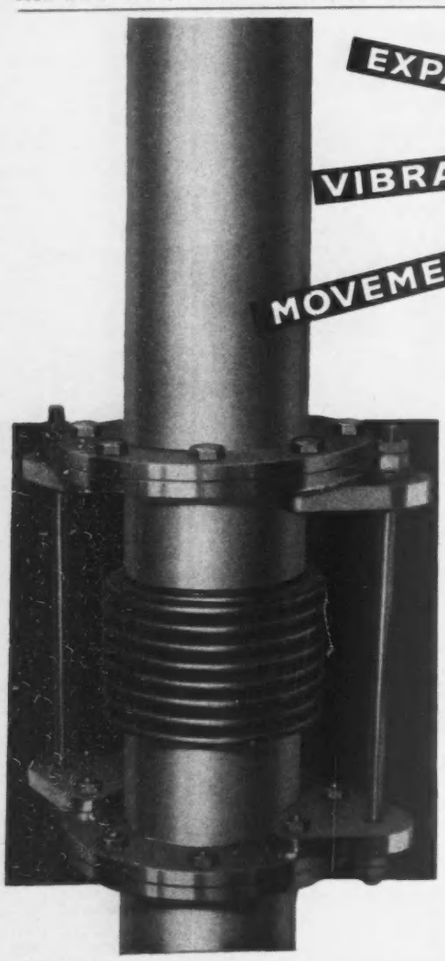

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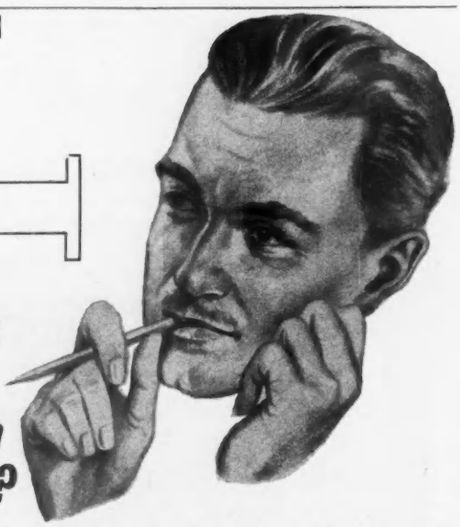

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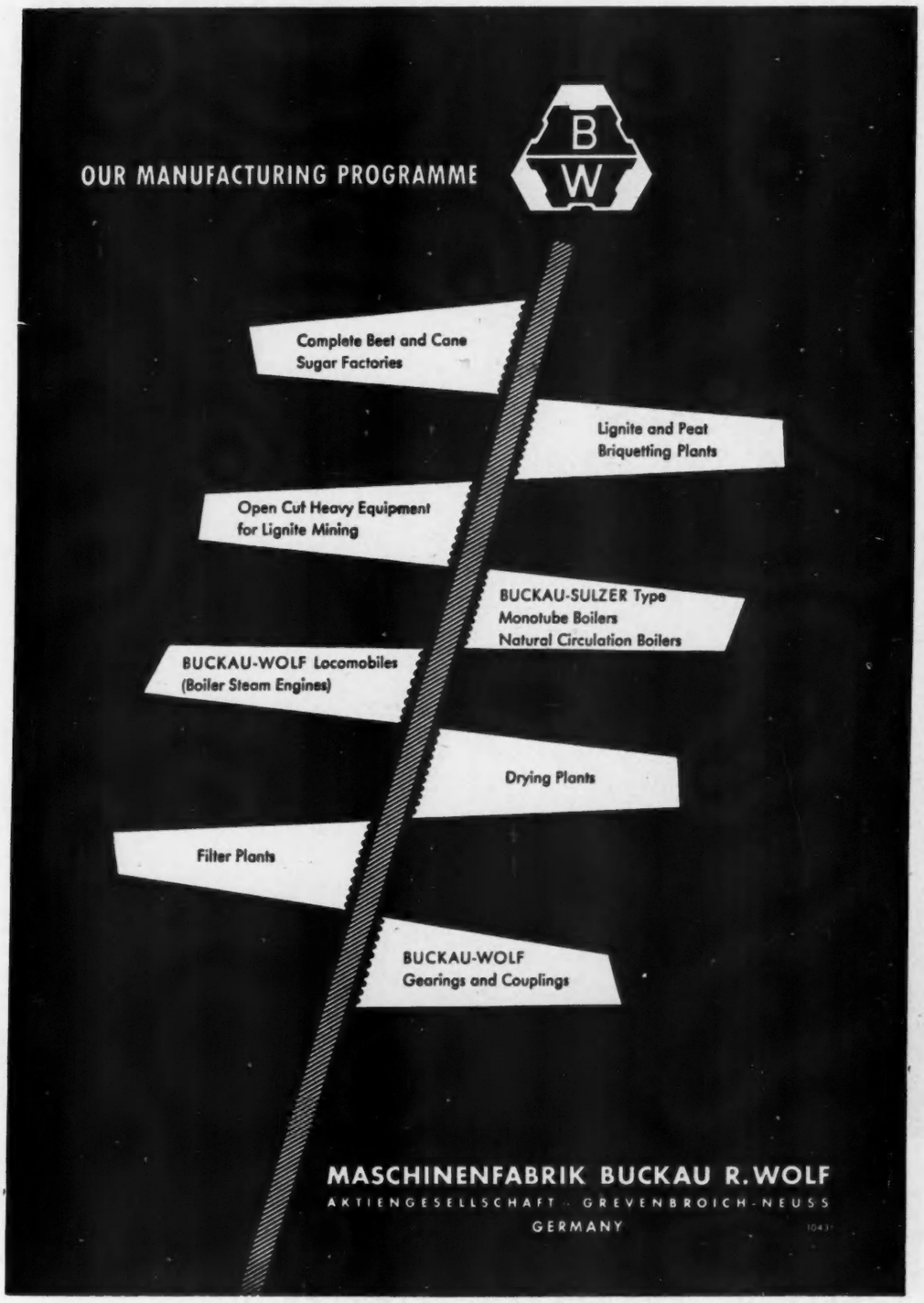

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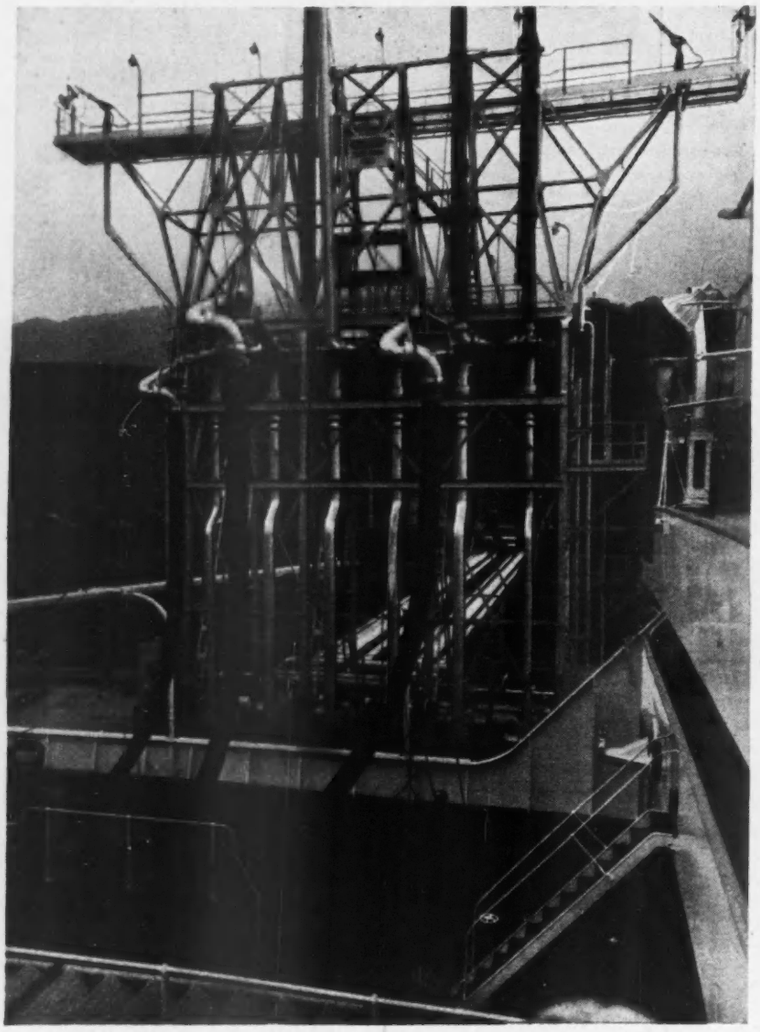
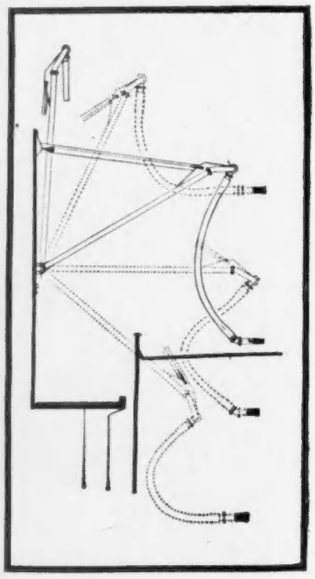
loads and unloads Tankers from 2,000 to 100,000 tons capacity

and allows for manifold rise and fall of 75ft.



Woodfield six-unit Flow Boom Equipment installed on Jetty 2 at Finnart Ocean Terminal of BP Refinery (Grangemouth), Limited, at Loch Long, Dumbartonshire.



Features:

★ Slewing arcs in excess of 120° allow wide tolerances in tanker spotting and drift.

★ With this equipment tanker manifold heights may vary by 75 ft. subject to sizes of tankers handled and local tide conditions.

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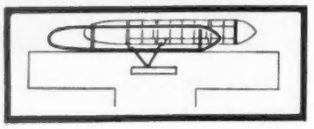

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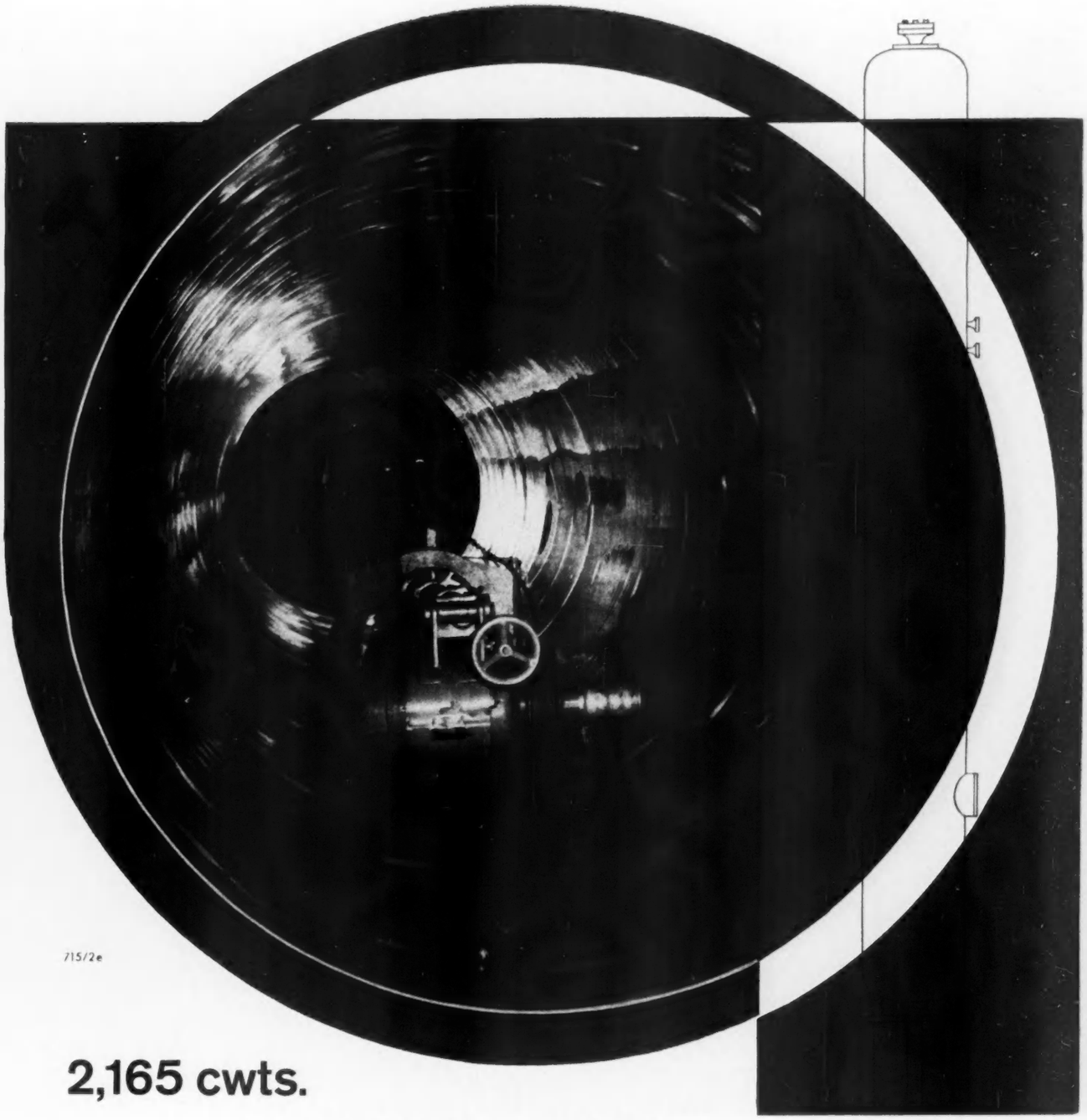

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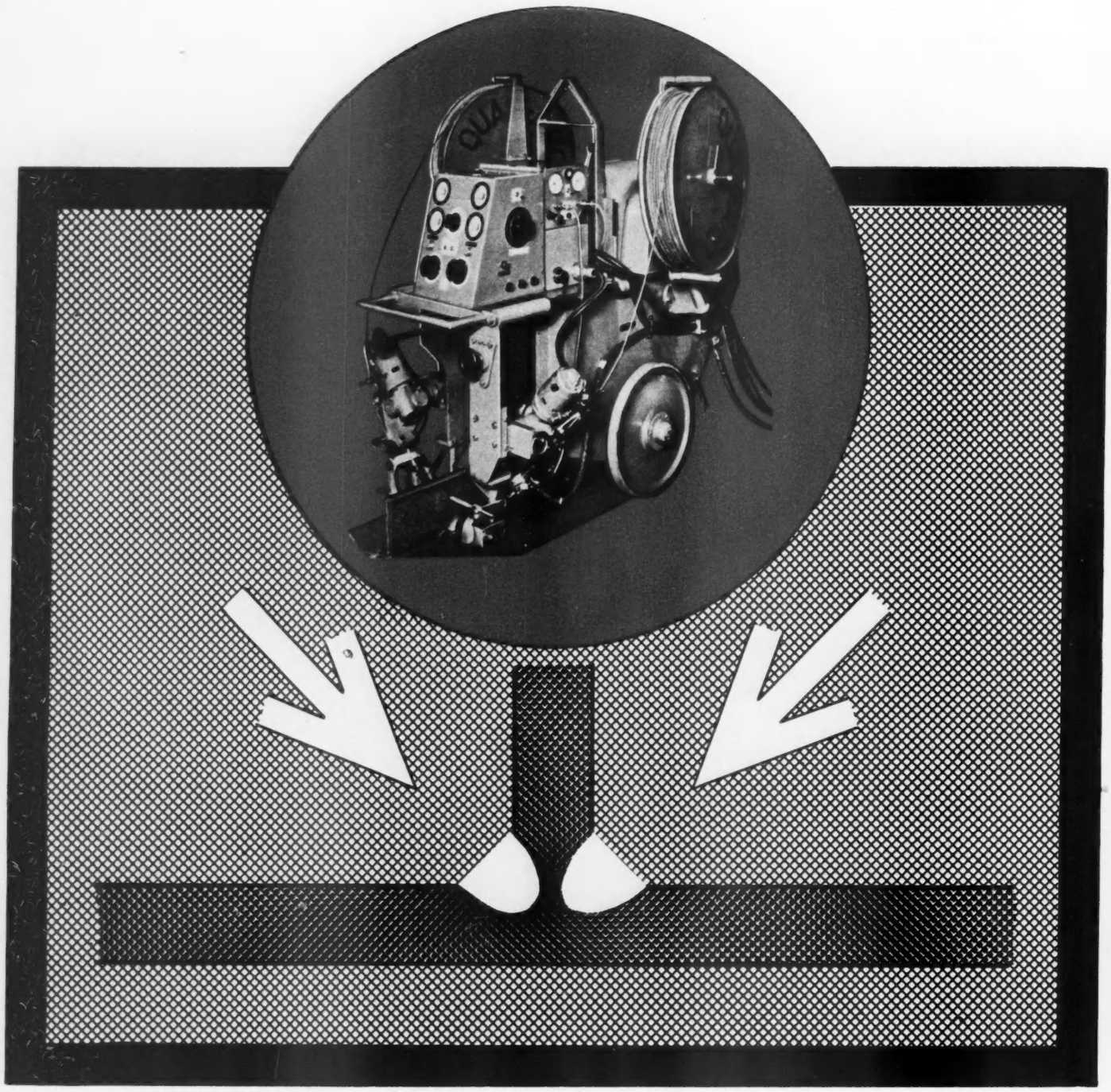

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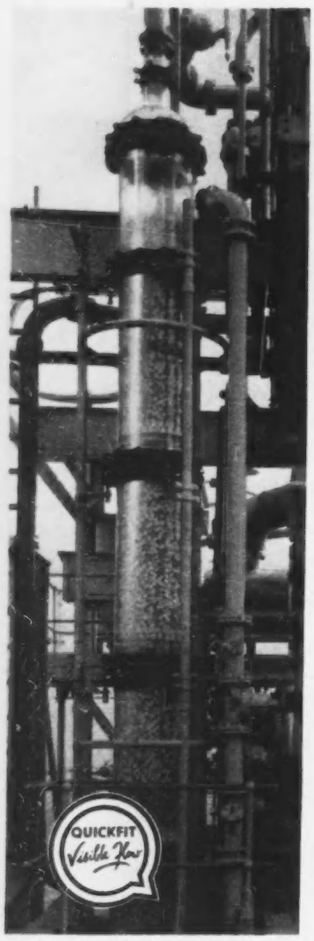

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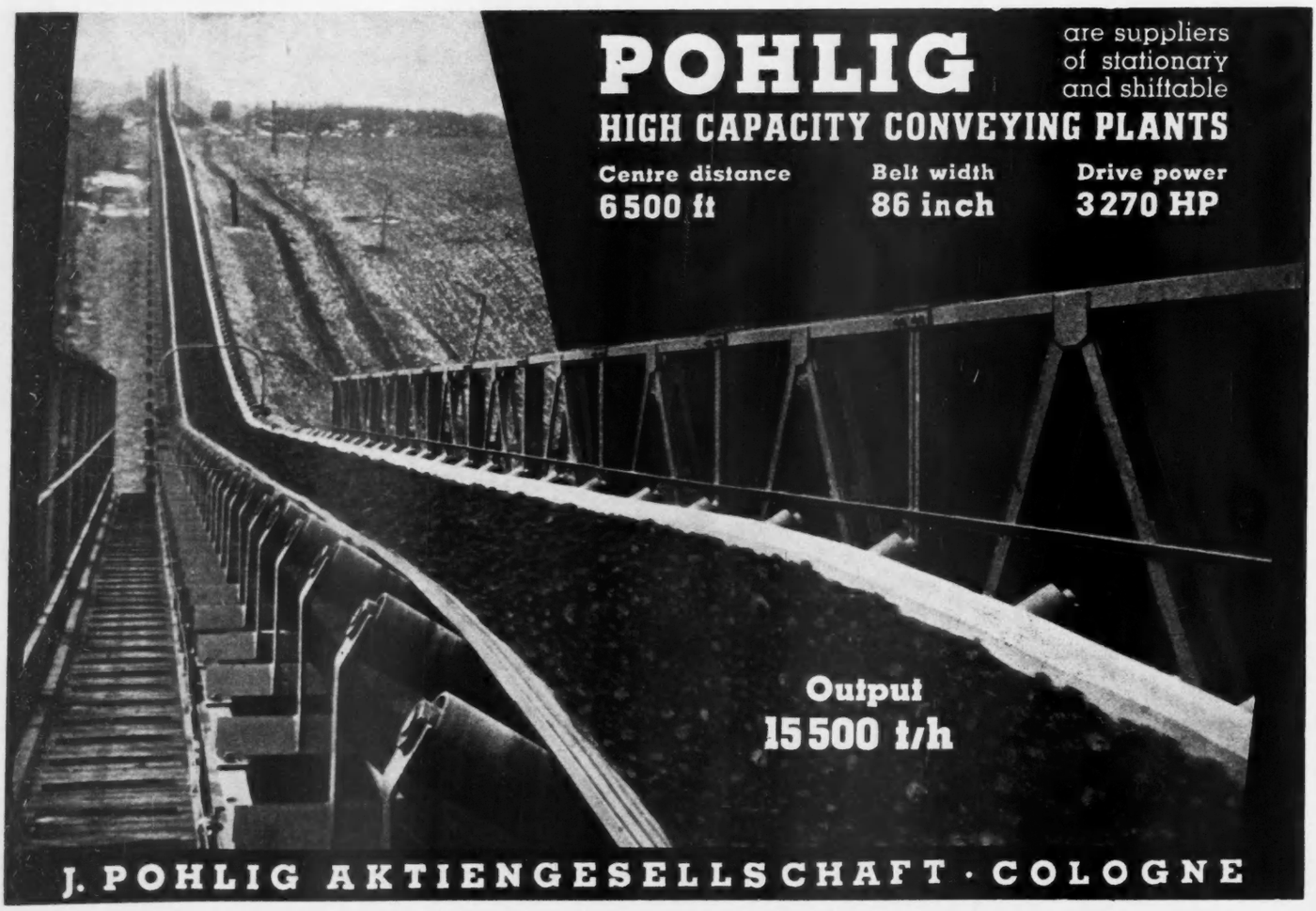

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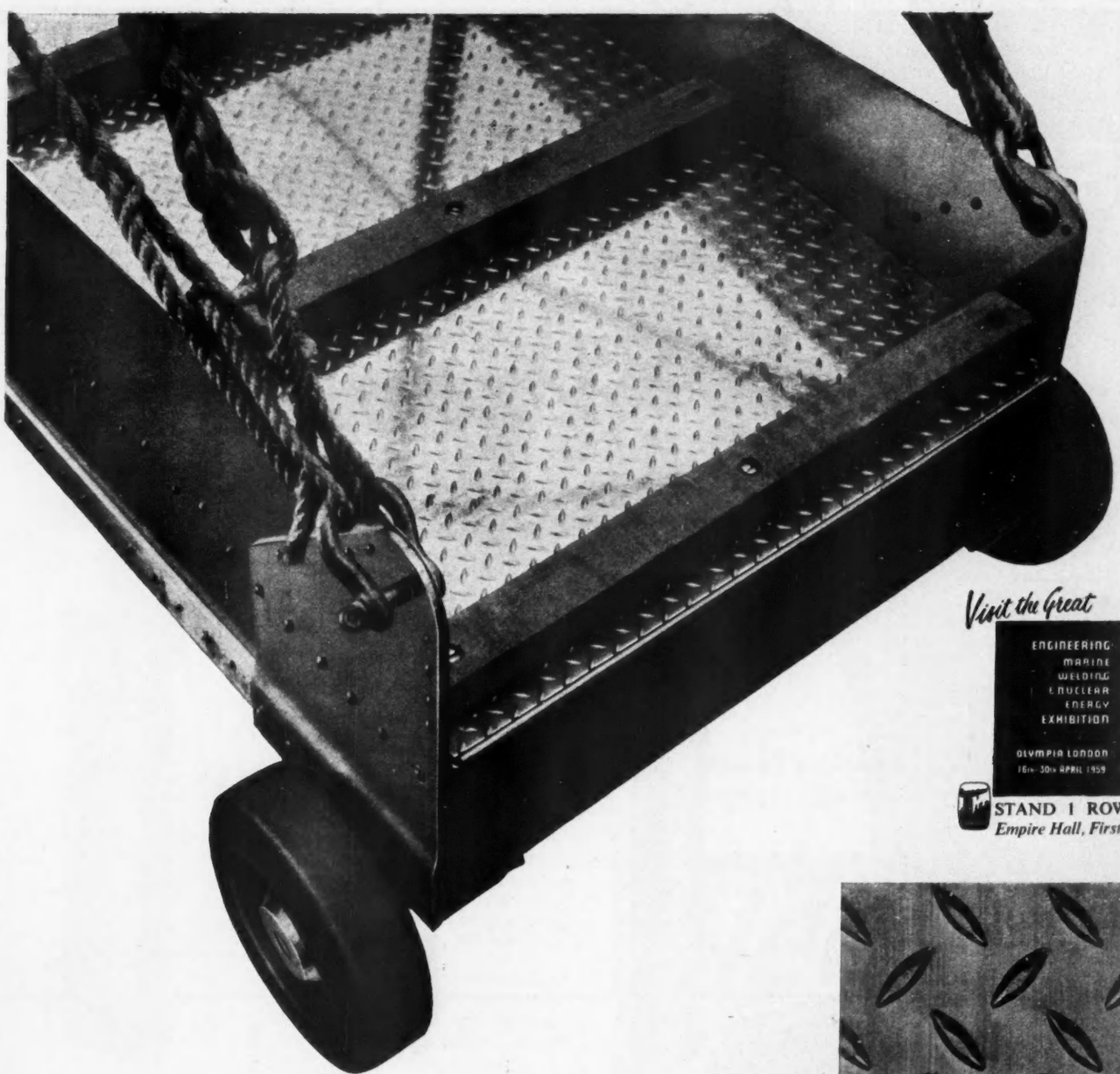

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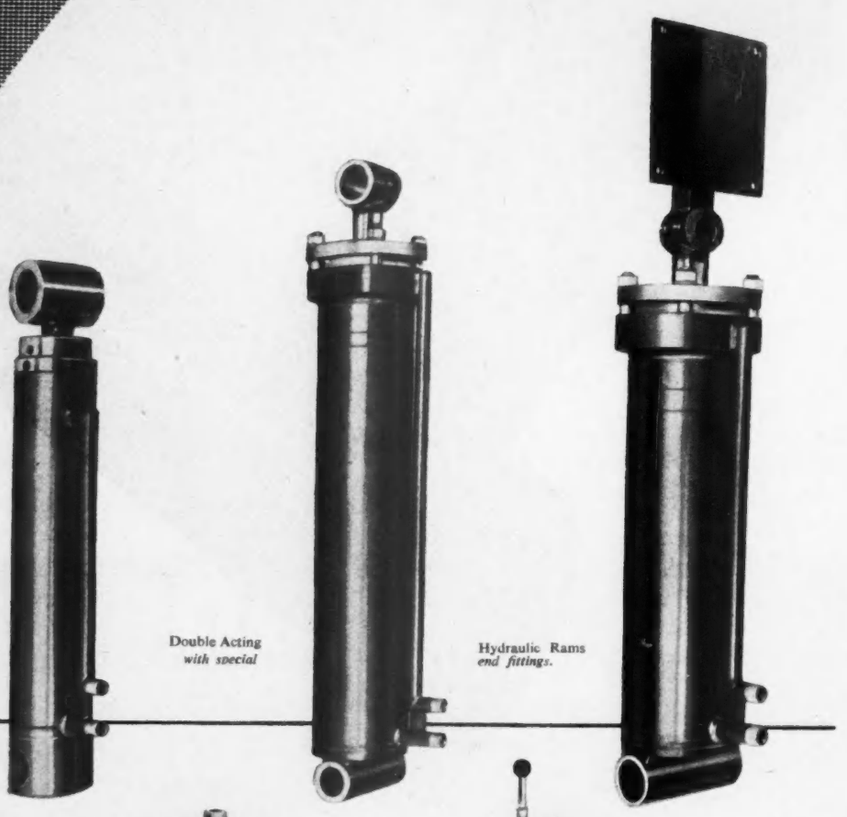

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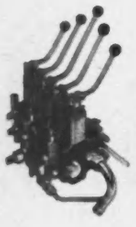

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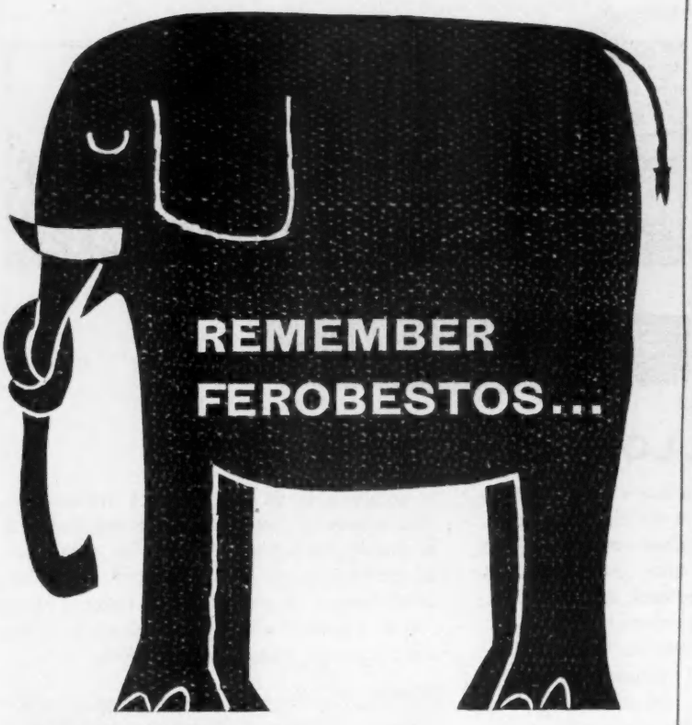

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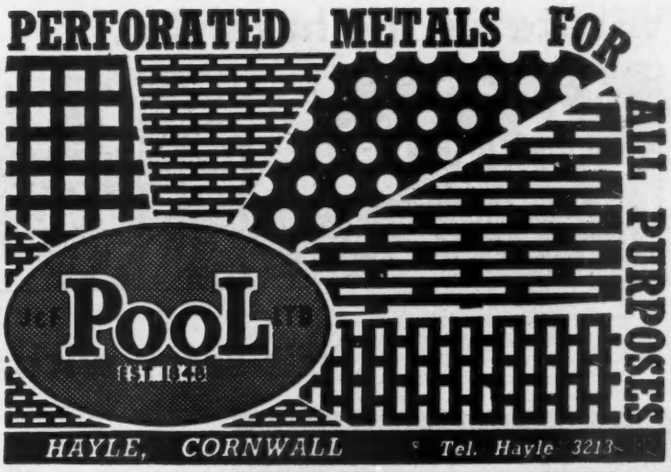

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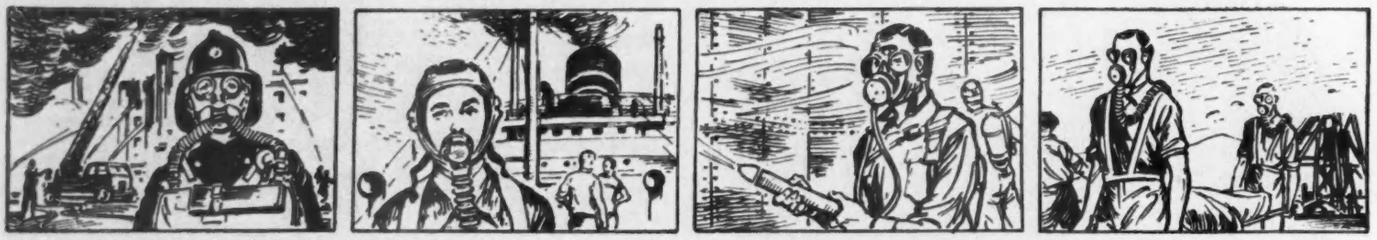

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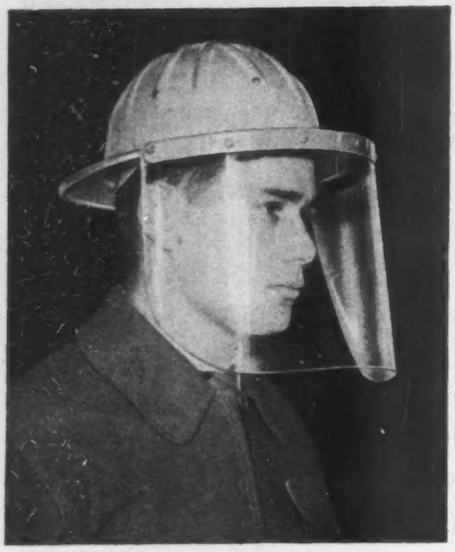

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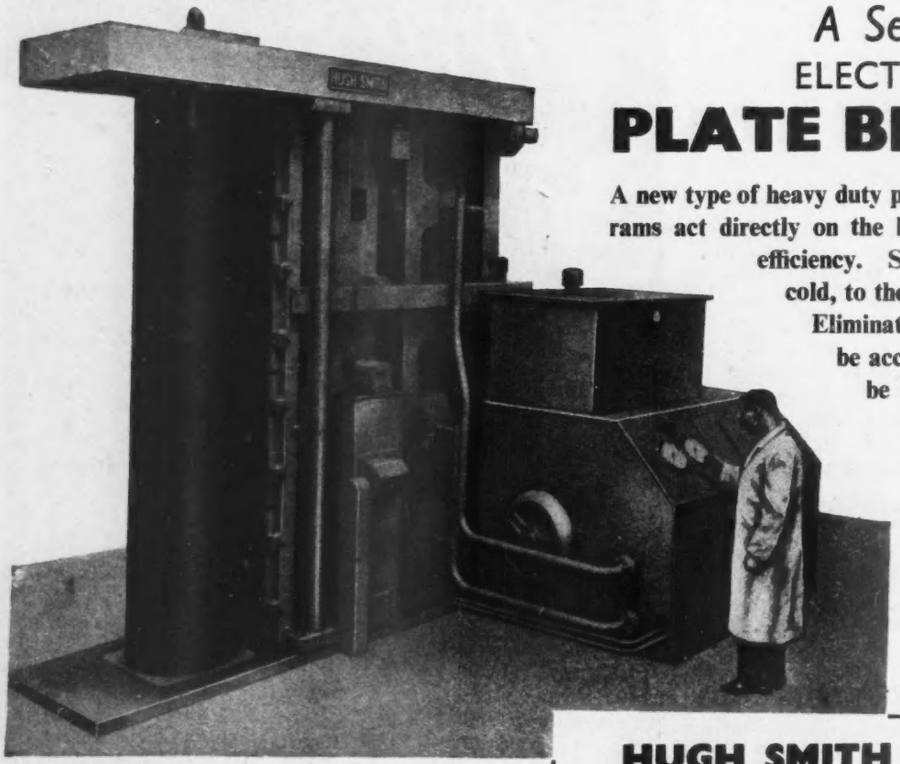

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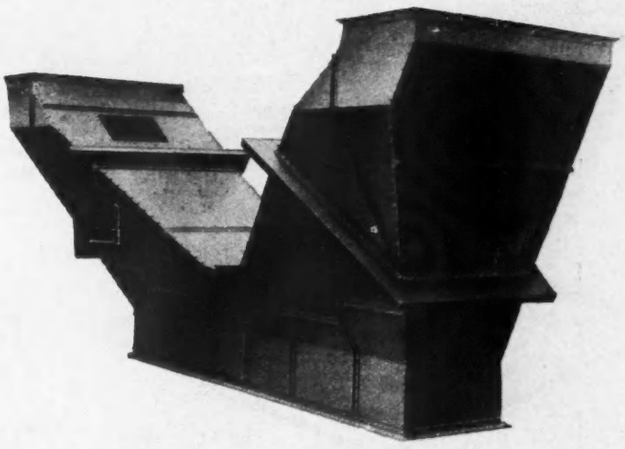

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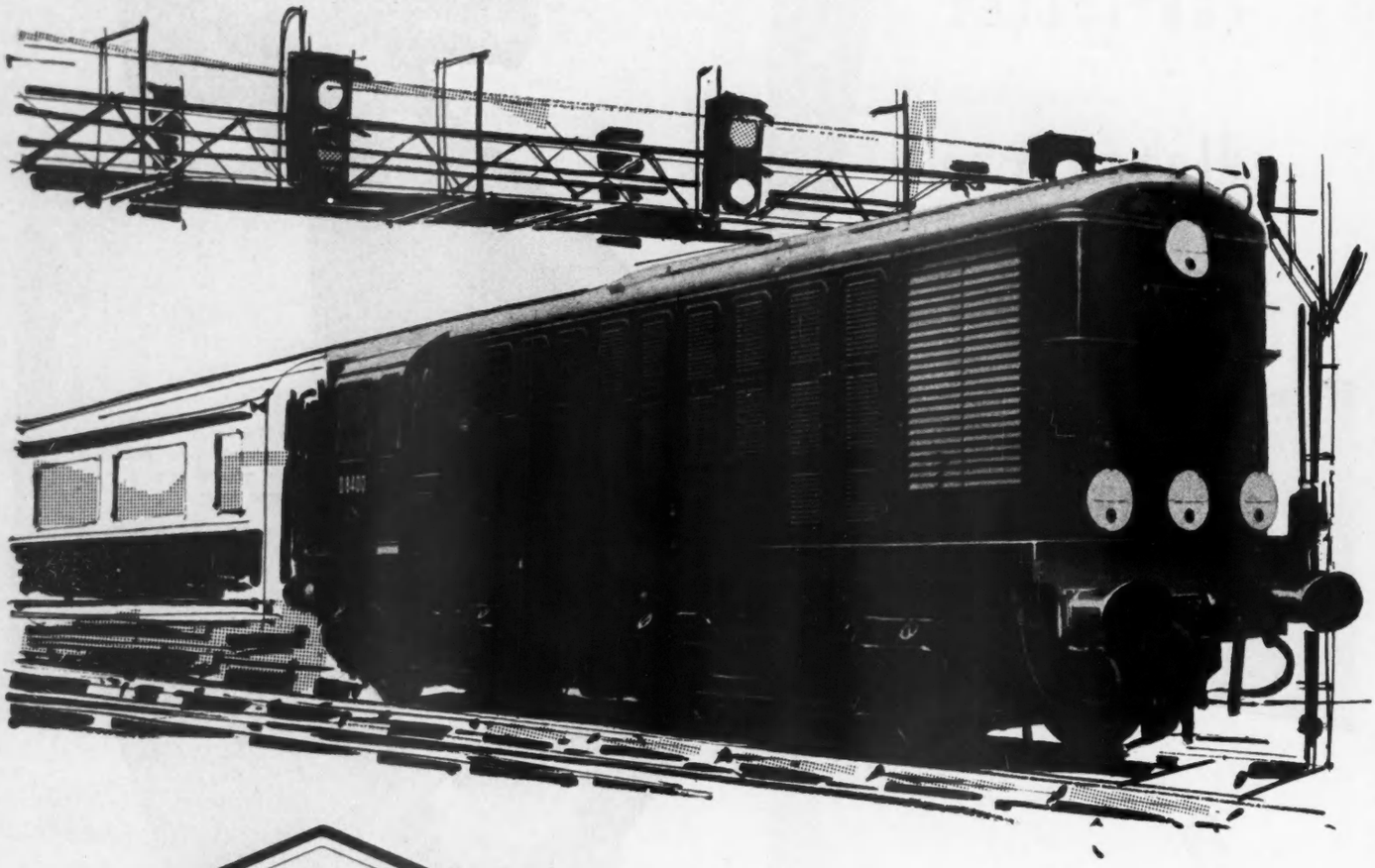

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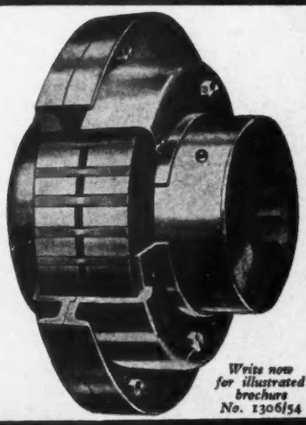

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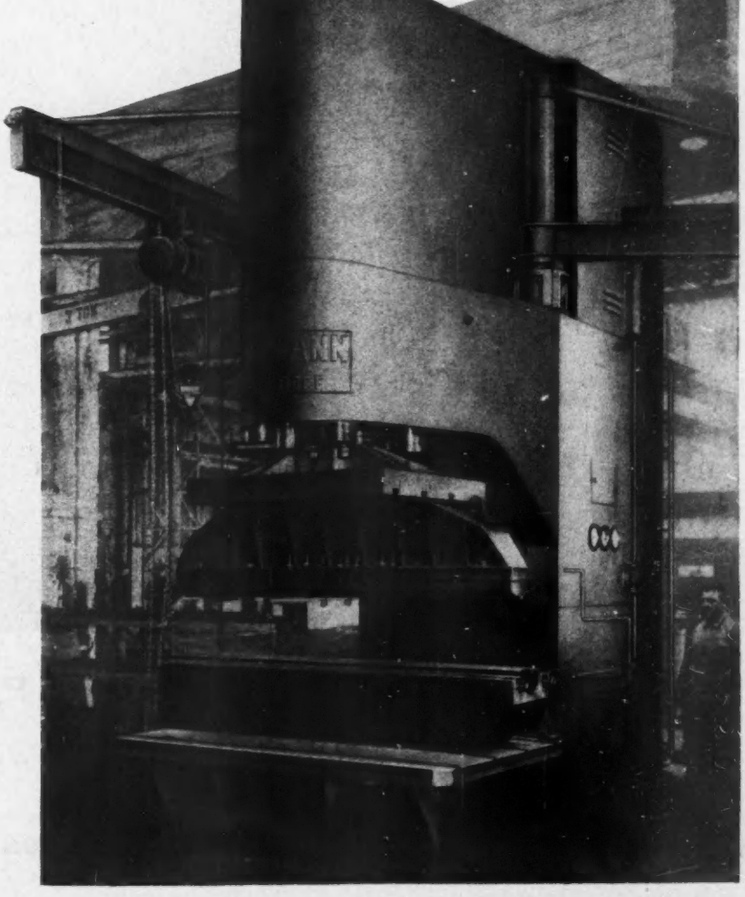

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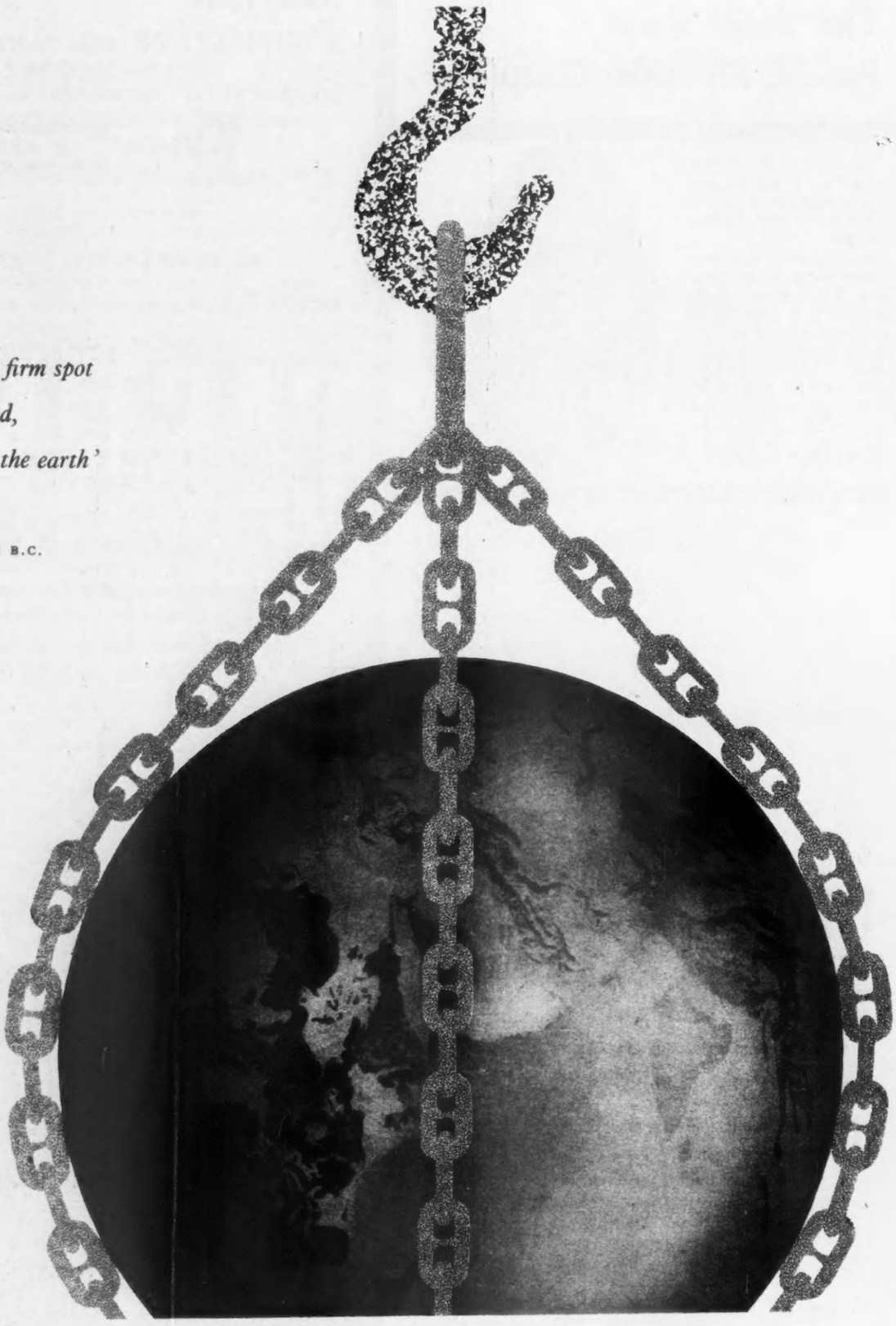

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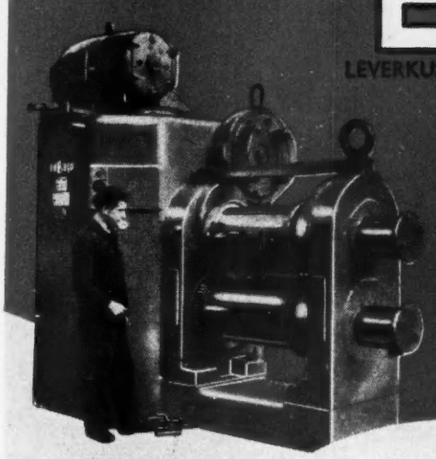

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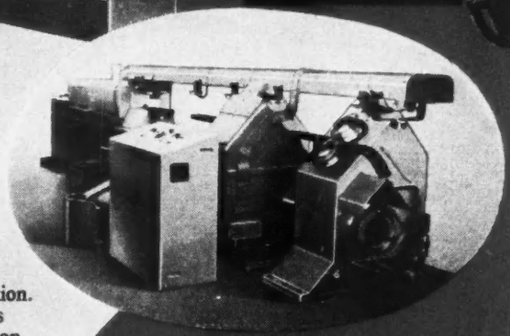

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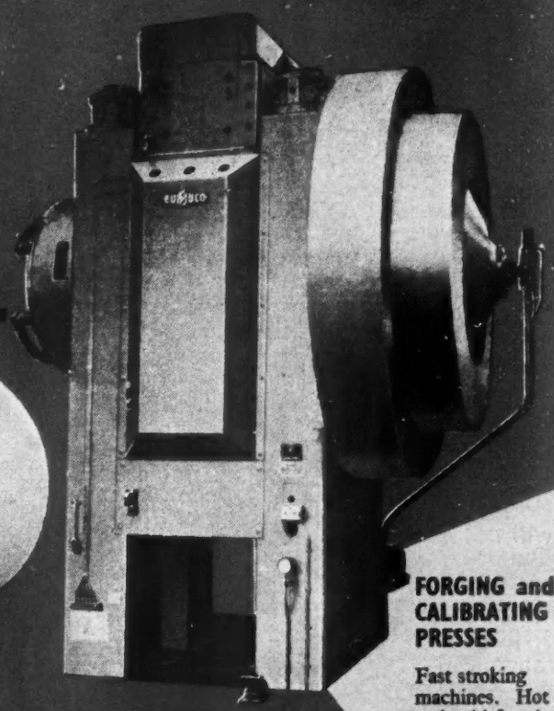

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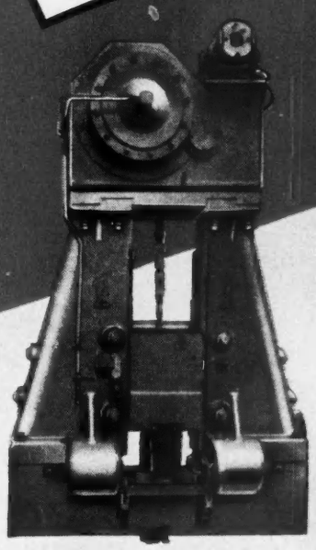

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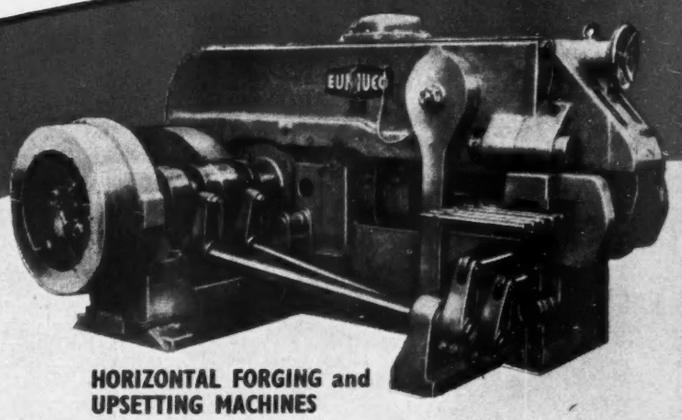

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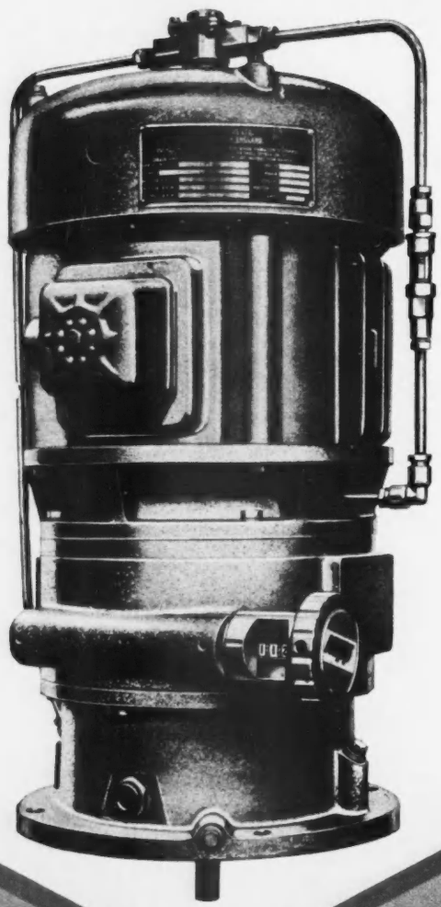

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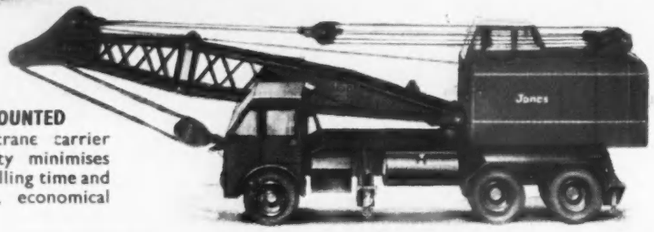

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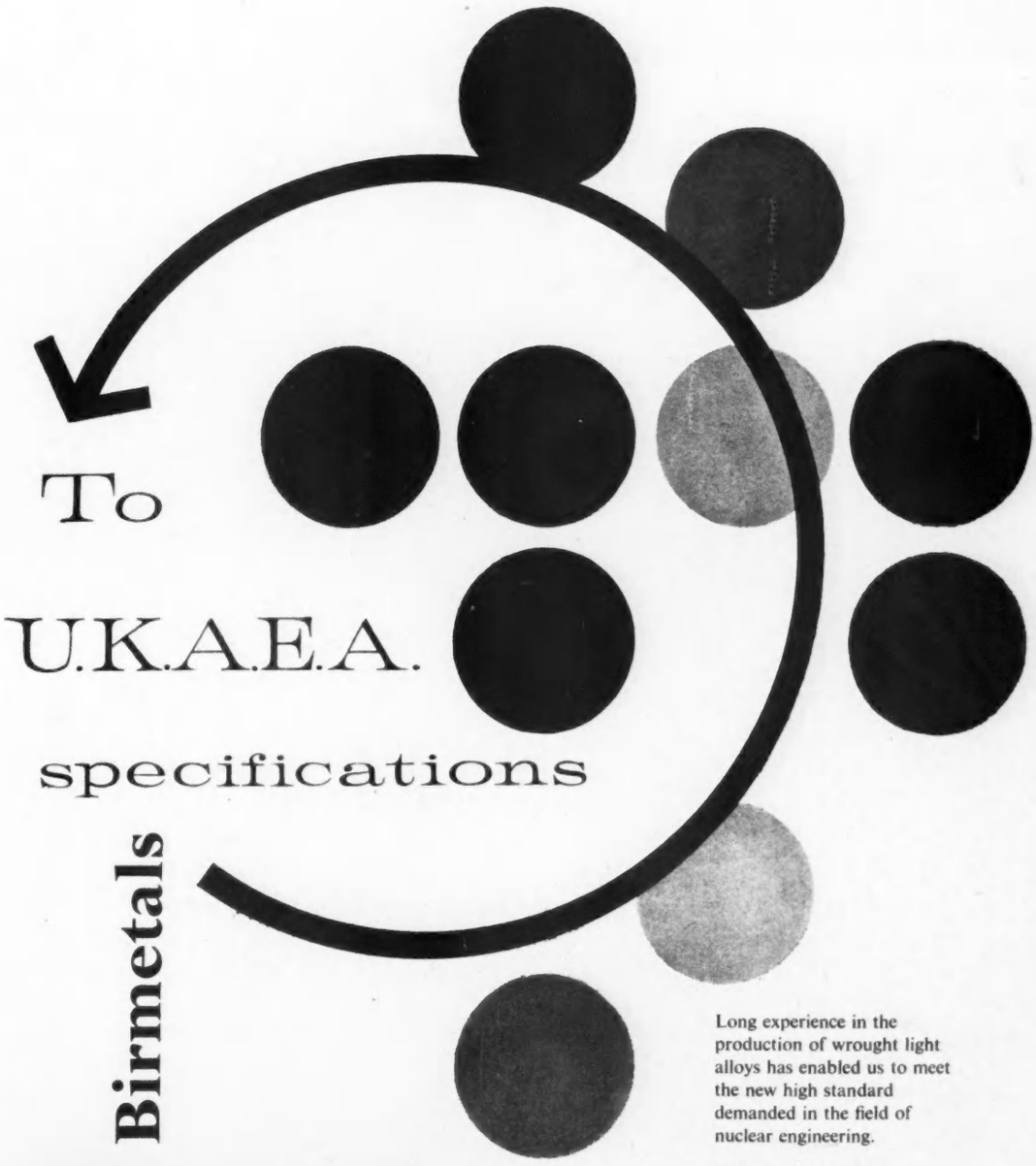

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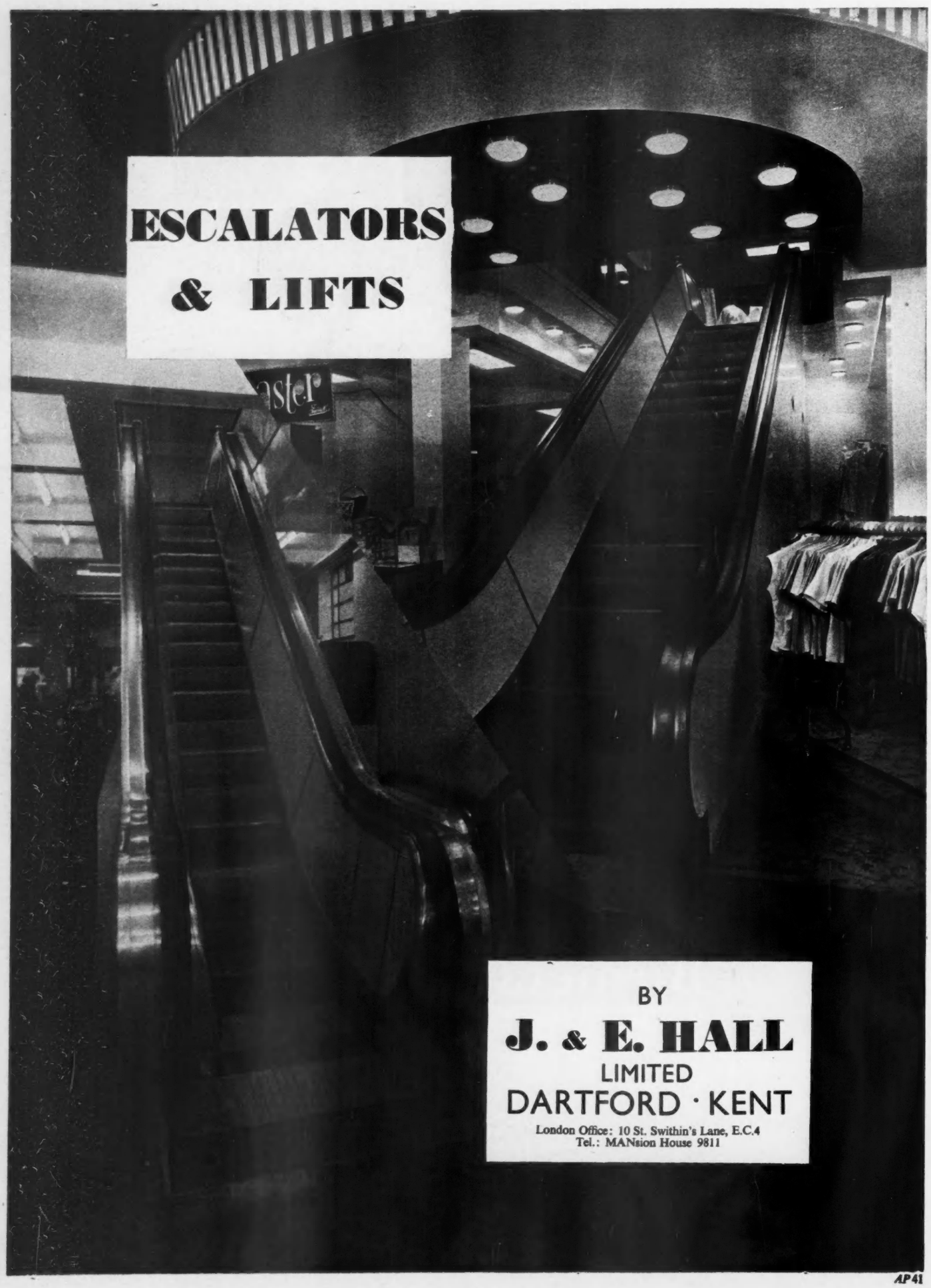
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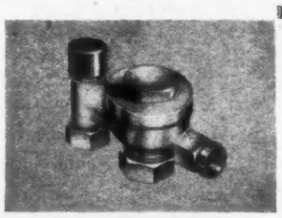

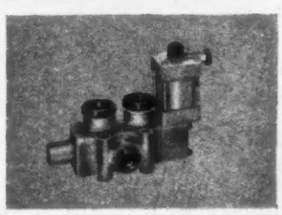

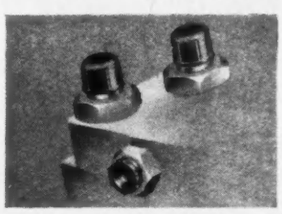

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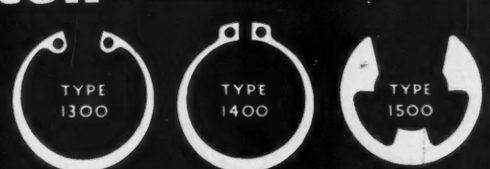

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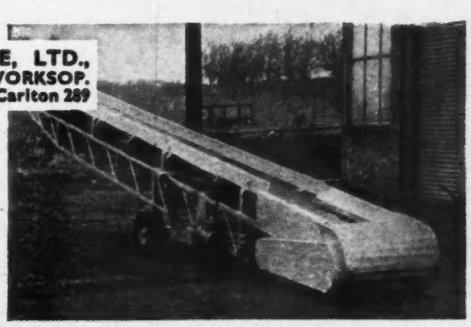

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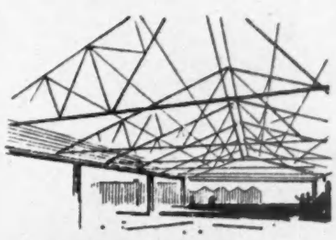

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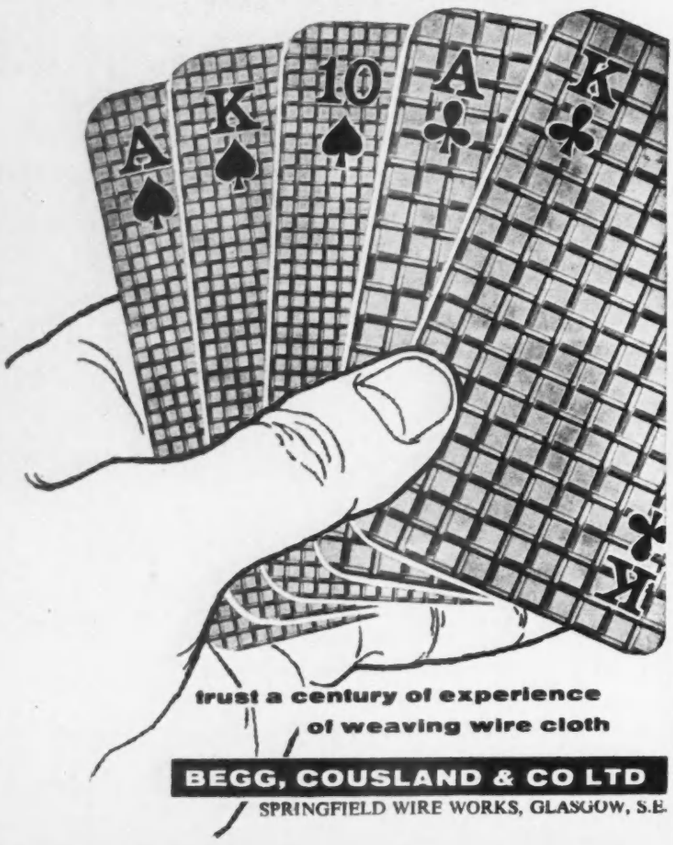

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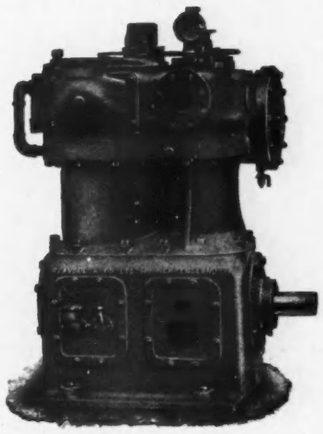

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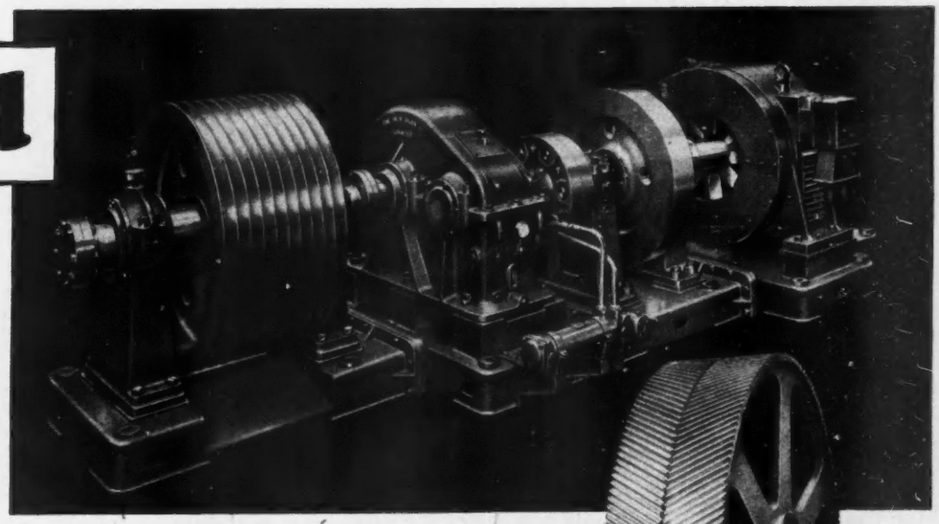

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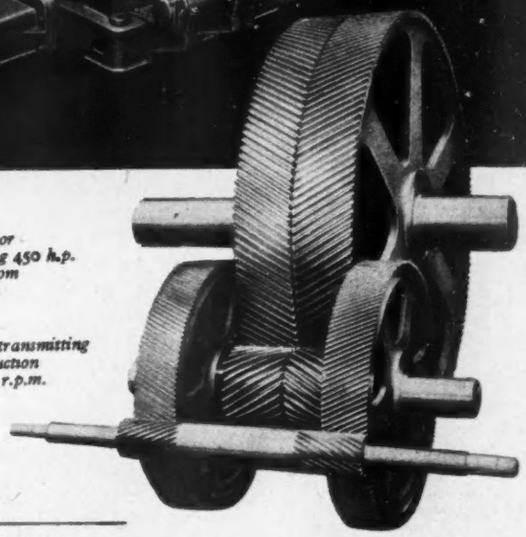

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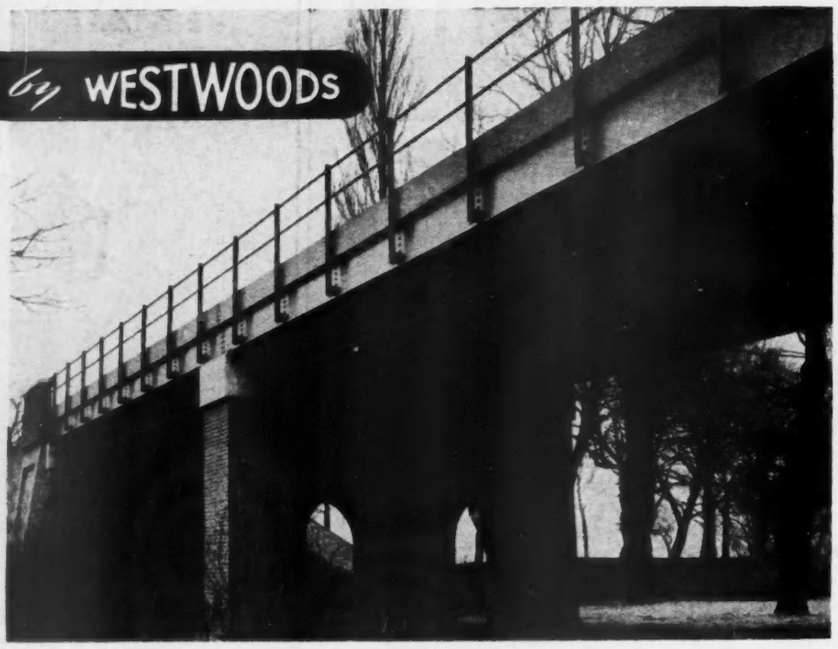

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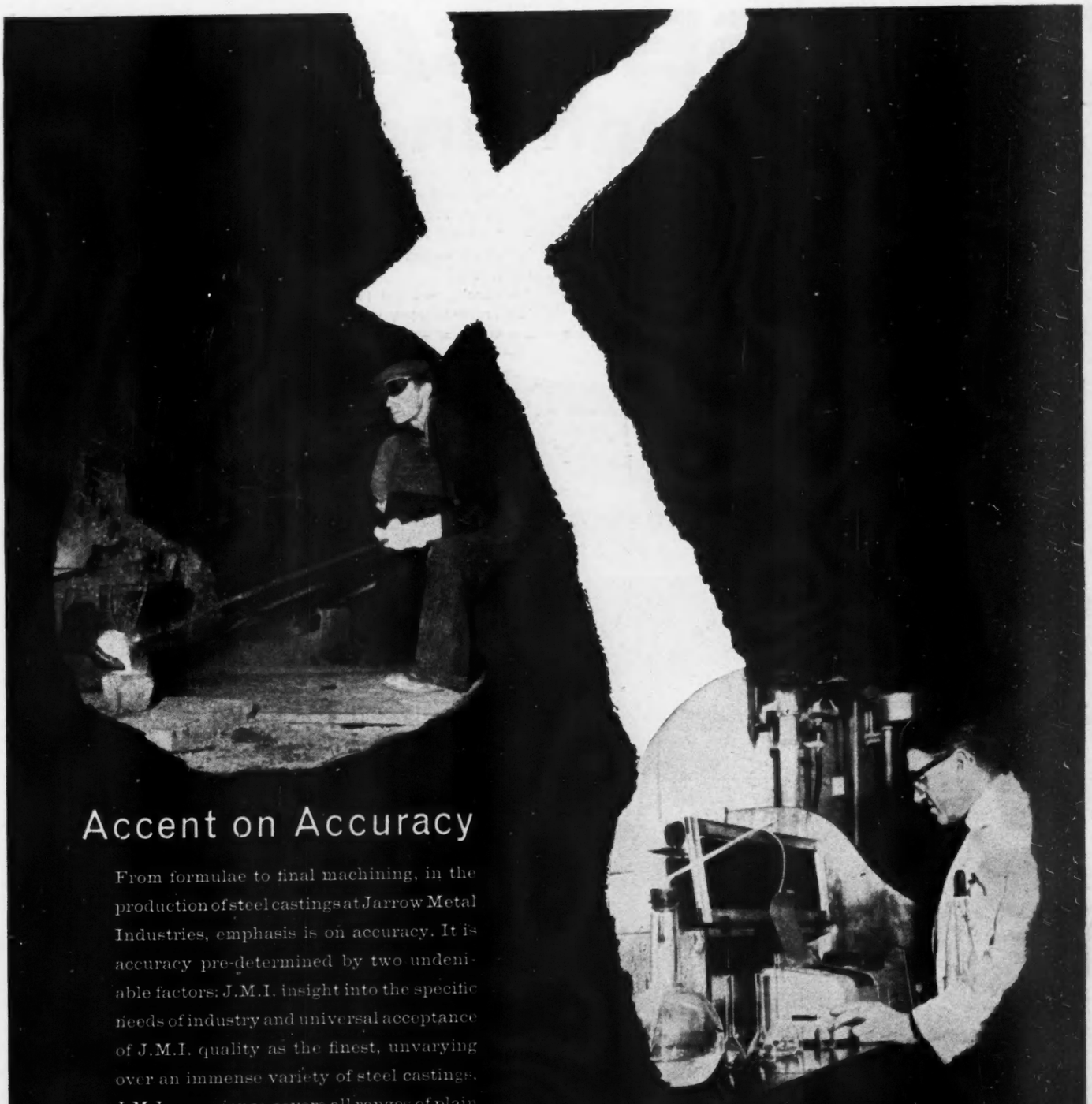

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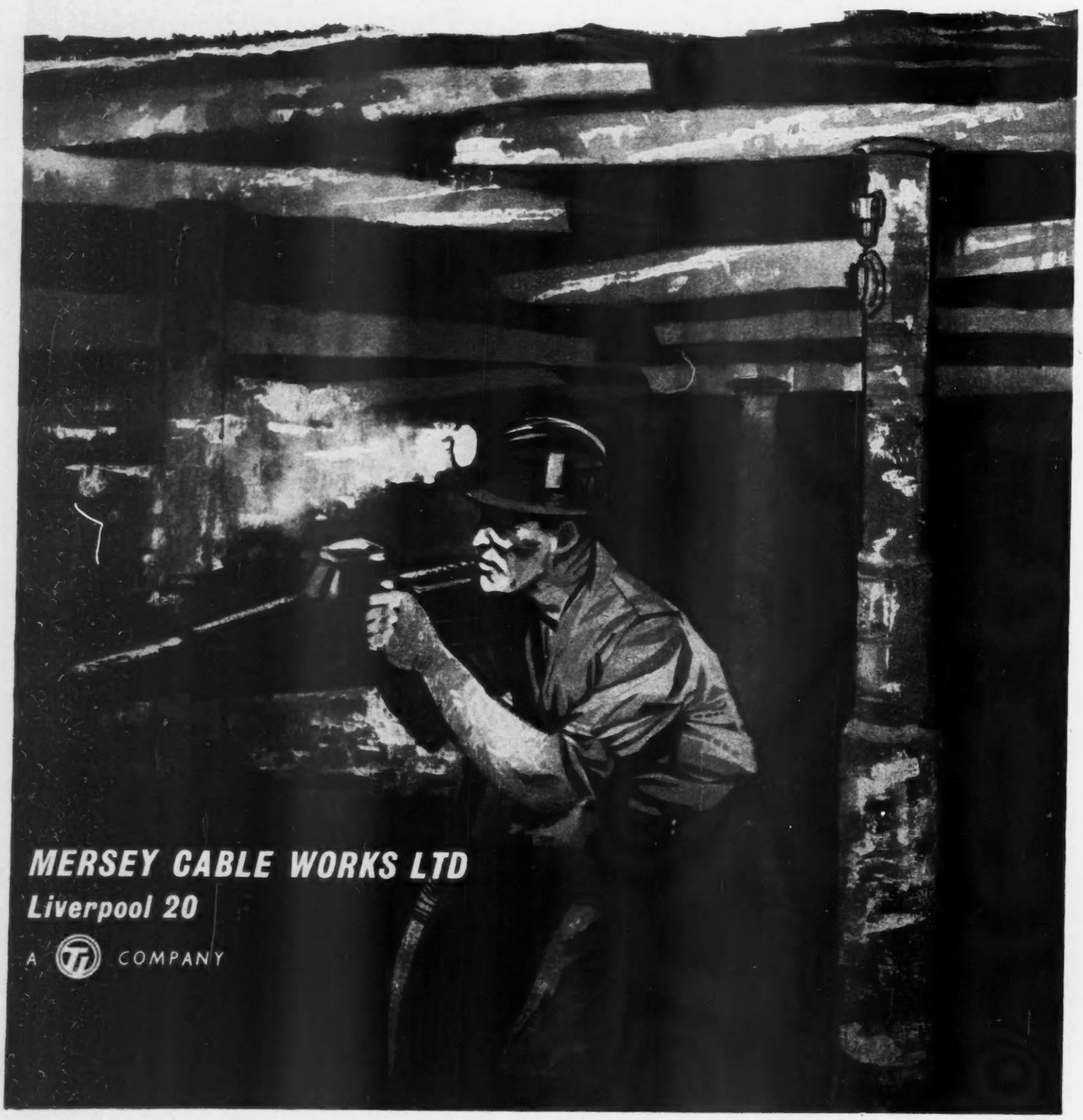

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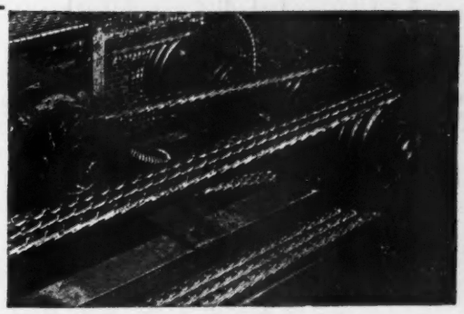

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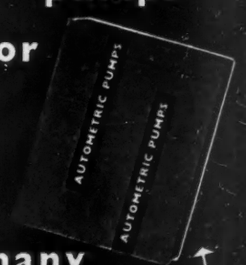

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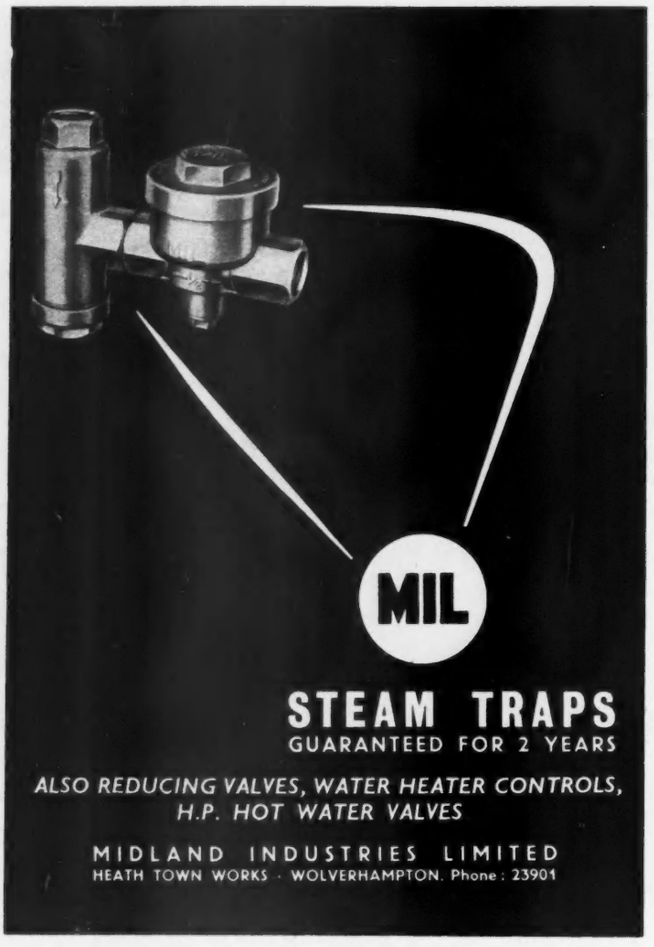

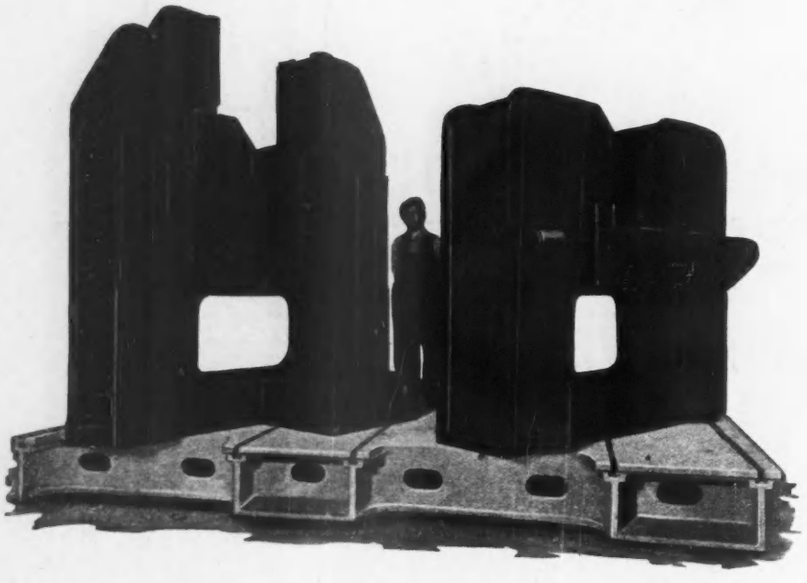

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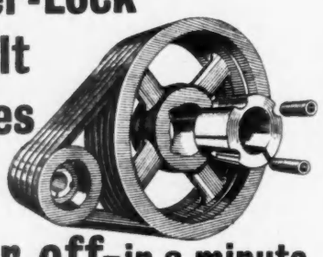

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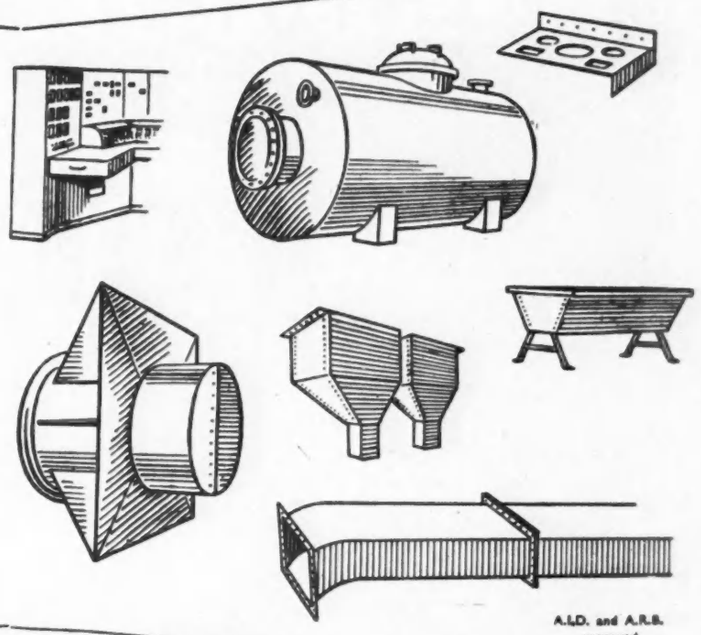

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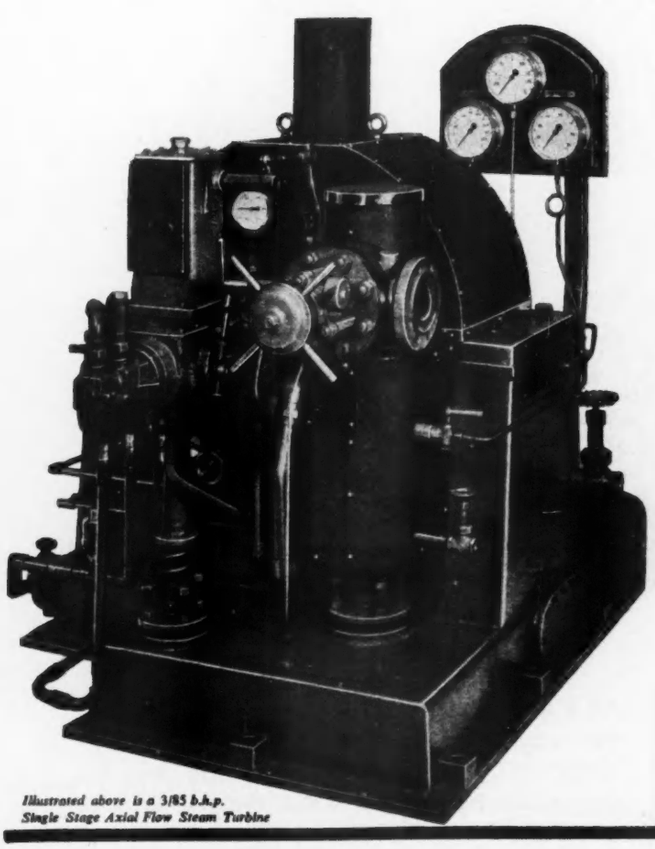

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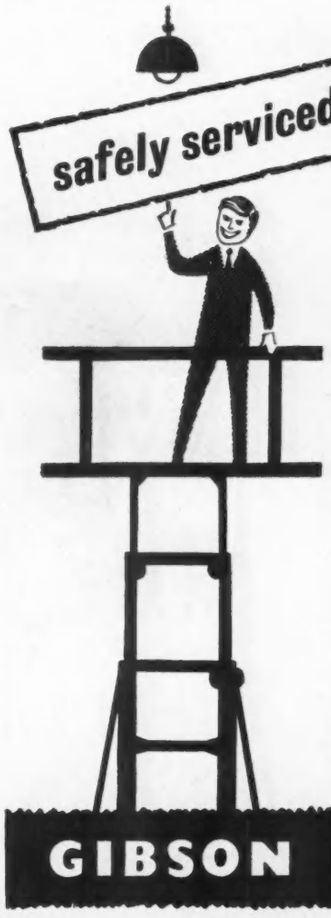

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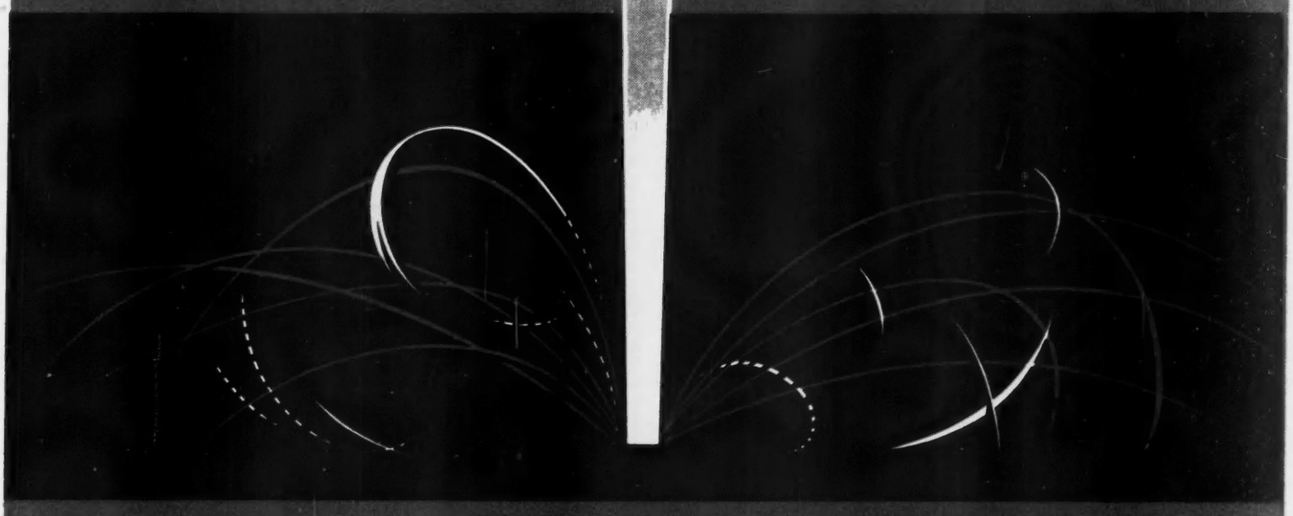

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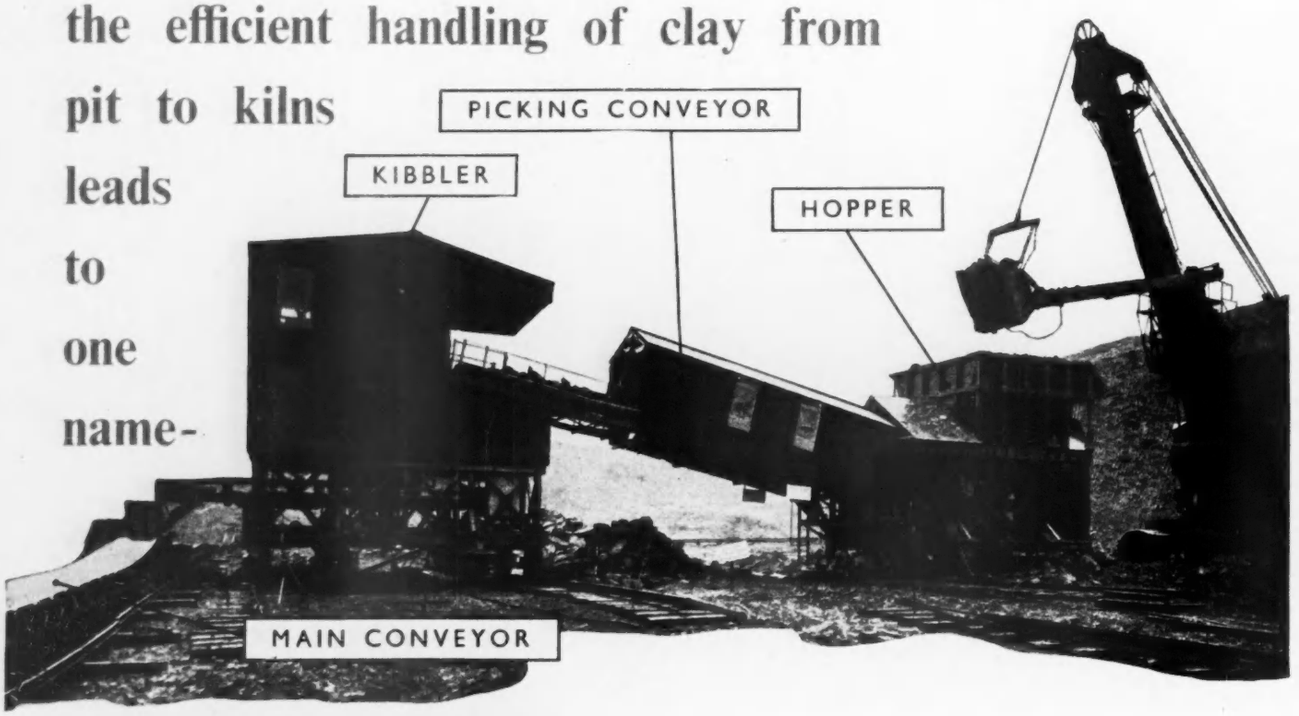

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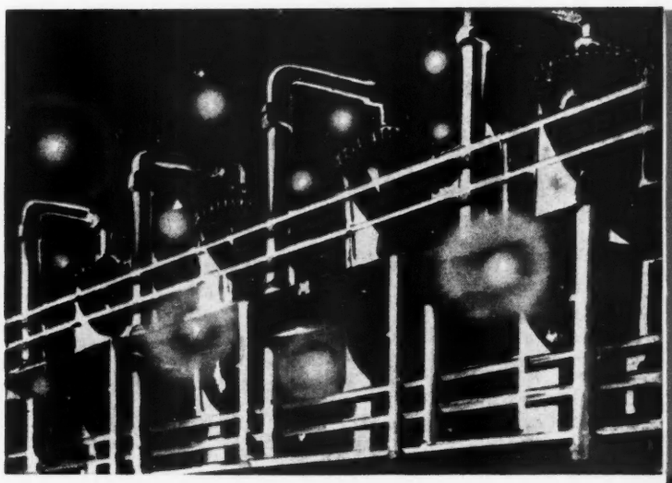

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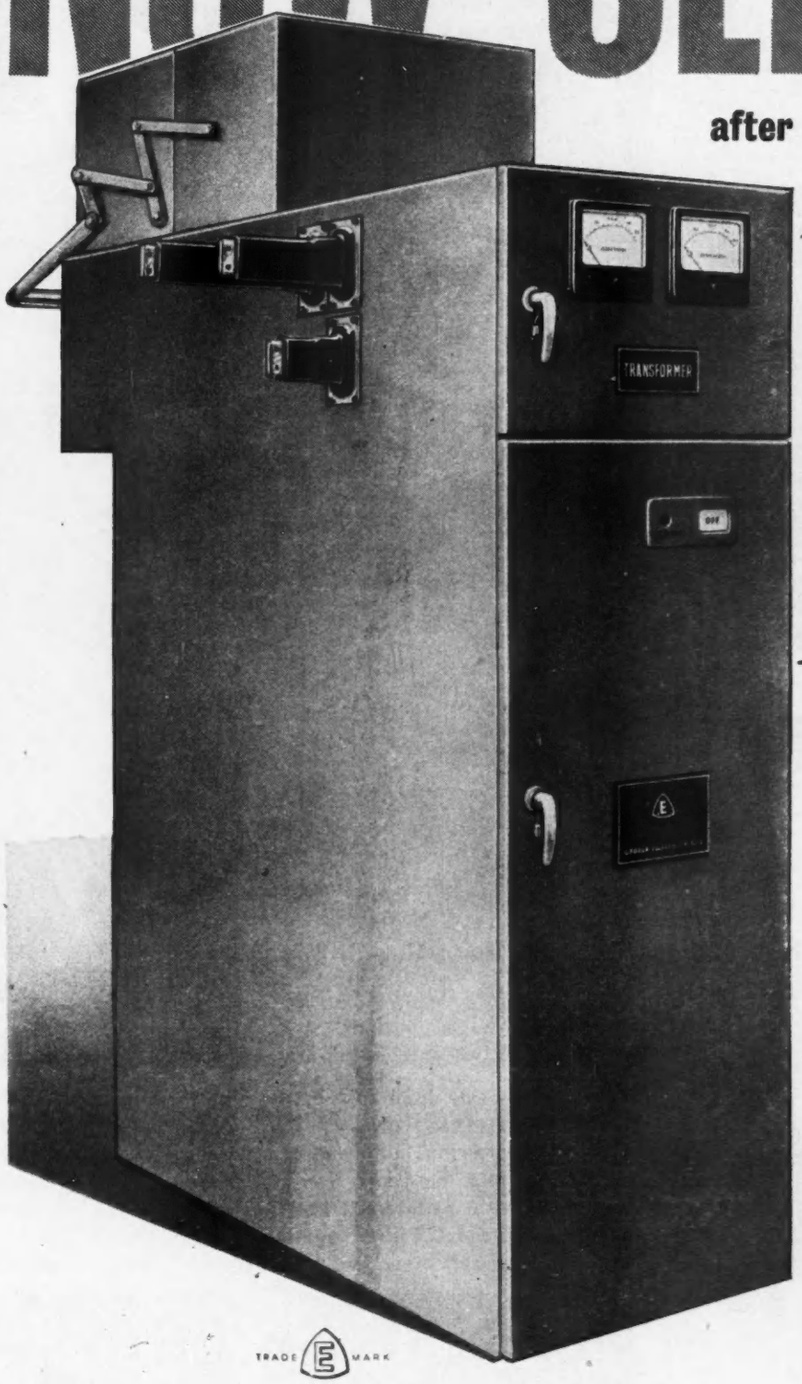

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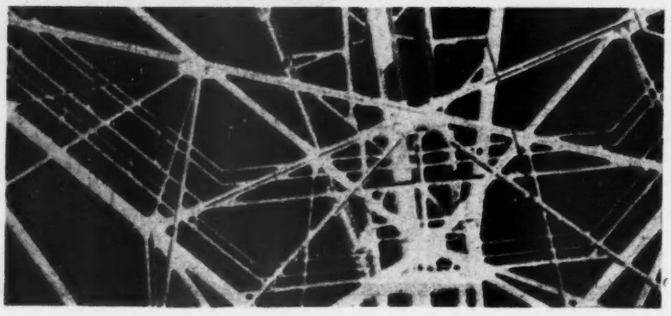
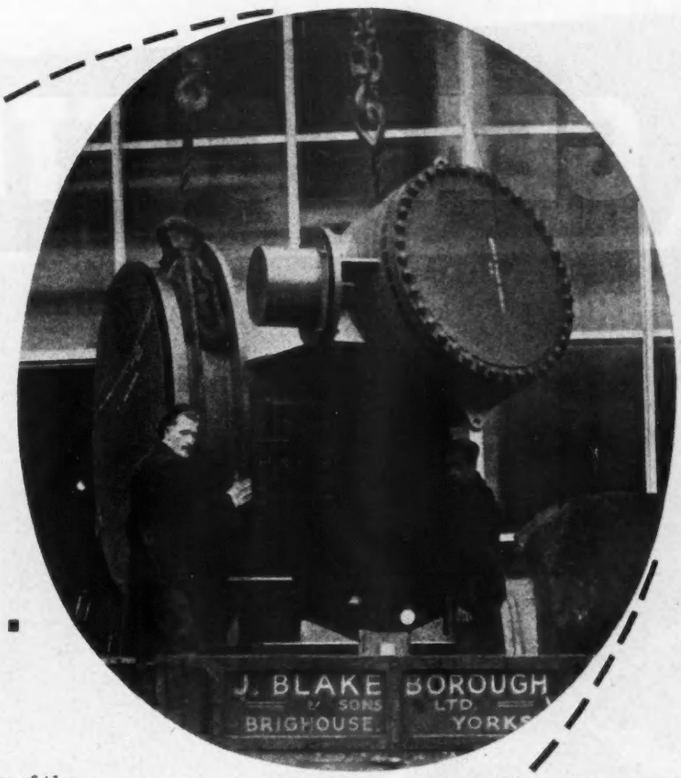
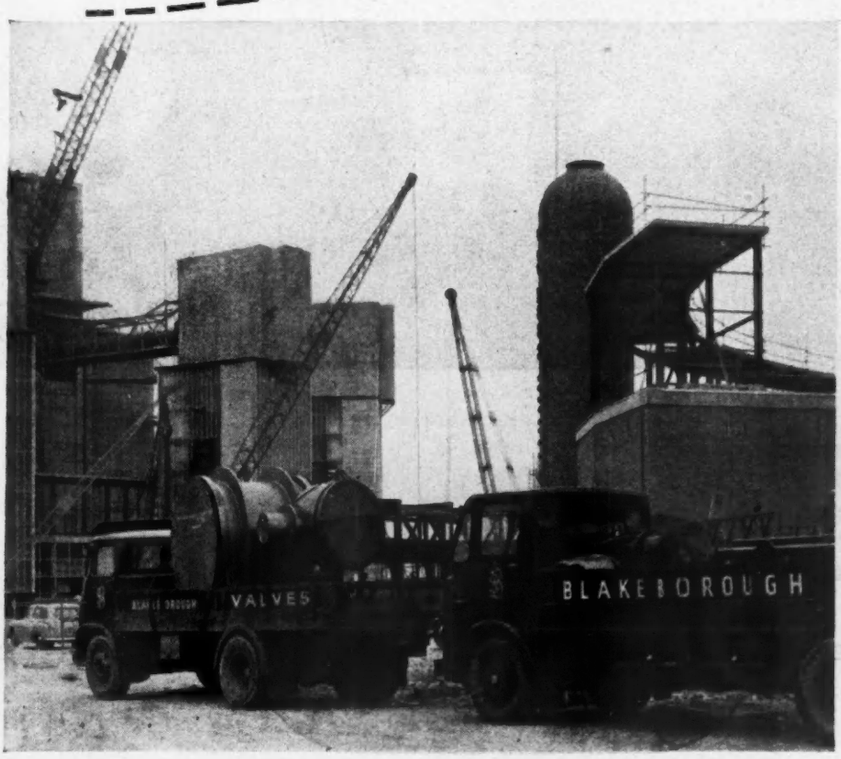


Valves for Berkeley Nuclear Power Station....



These photographs, reproduced by courtesy of the AEI—John Thompson Nuclear Energy Co. Ltd., show part of a consignment of Blakeborough valves on arrival at Berkeley Power Station, from contracts covering the following material:—



*__Reactor main gas duct isolating valves.__ 60 in. bore, motor operated, stressed-seal Butterfly type.

*__Valves for SECONDARY CO2 circuits.__ Globe and gate types, with bellows seal.

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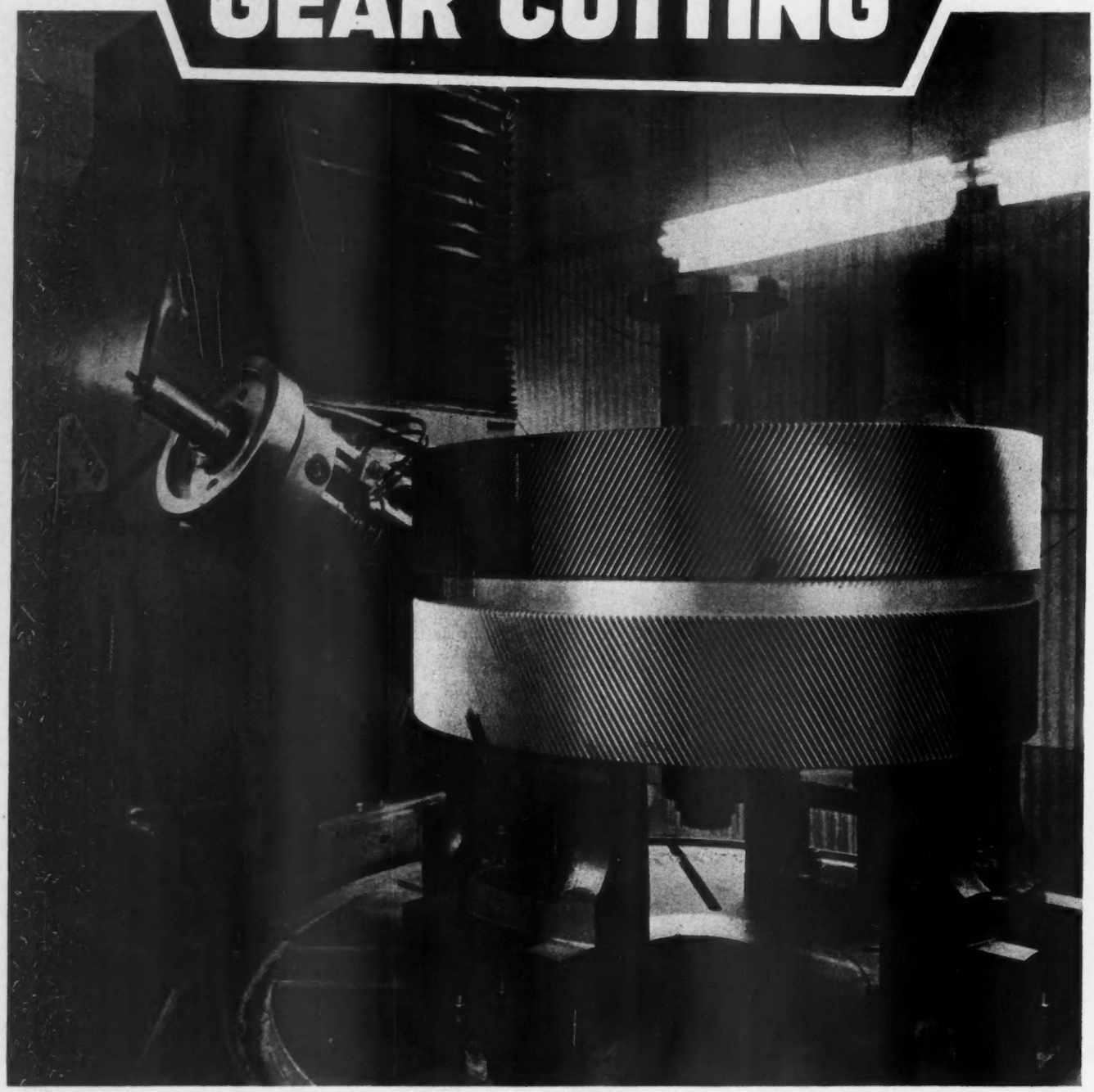

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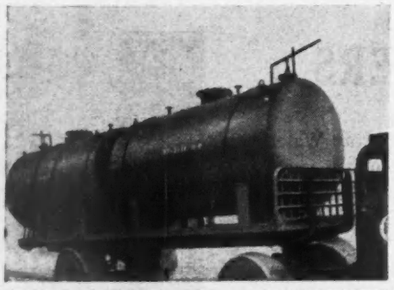

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Aeroflex

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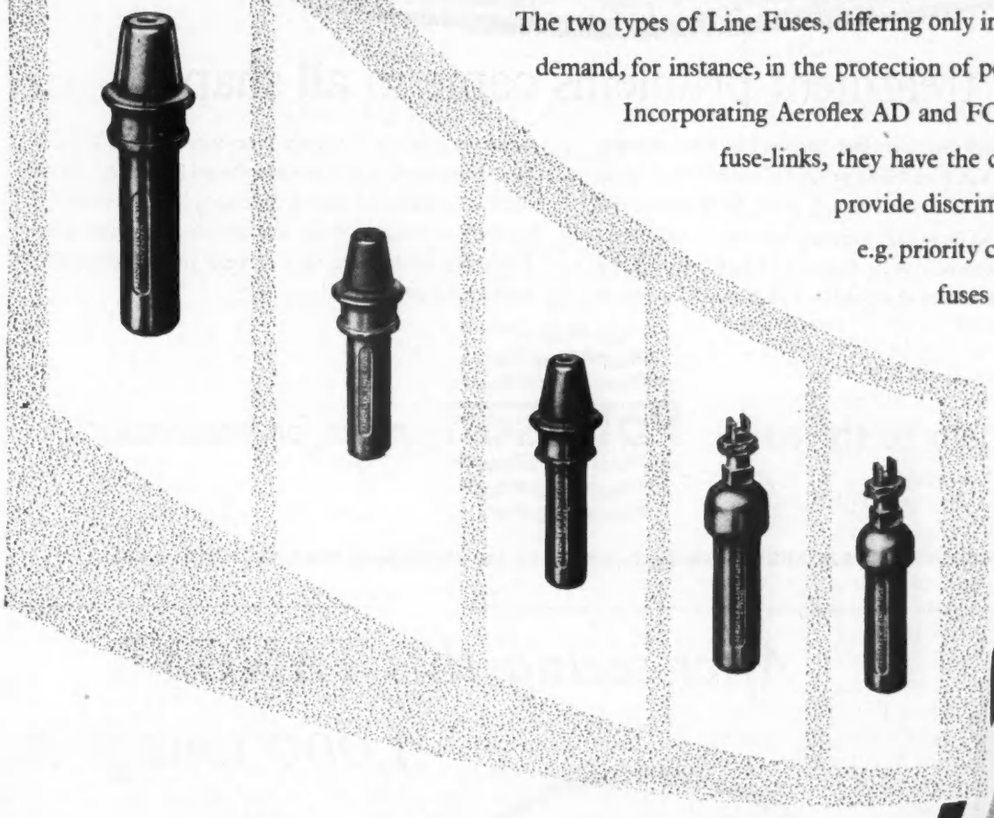
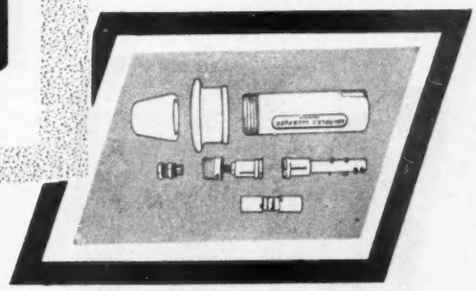


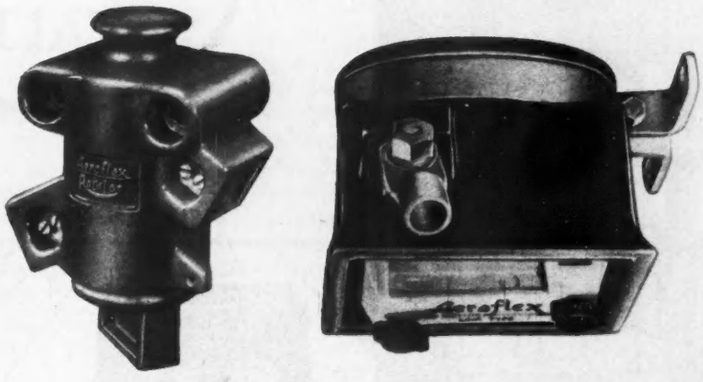
The two types of Line Fuses, differing only in connection, meet a steady demand, for instance, in the protection of pole-mounted transformers. Incorporating Aeroflex AD and FC type rewireable cartridge fuse-links, they have the characteristics necessary to provide discriminatory reaction to faults; e.g. priority can be given to consumers' fuses on house service cut-outs.

The subject is fully dealt with in our publication No. AL2.



OVERHEAD LINE FUSES

The illustration shows examples from a considerable range of overhead line fuses to suit different situations:—on the left an Aeroflex 60 amp. Rotaloc line fuse is shown, suitable for securing to the cross bar of a line support, and having an adaptable fuse handle carrying an Aeroflex high breaking capacity 60 amp. ADS type rewireable cartridge fuse-link. The right hand illustration shows a 200 amp. porcelain enclosed line fuse, embodying Link Type handle with Aeroflex Ceram high breaking capacity rewireable cartridge fuse-link.



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No. 5386 APRIL 17, 1959 VOL. 207

COMPETITION AND THE AIRCRAFT INDUSTRY

Yesterday and to-day, the southern section of the Institution of Production Engineers is devoting its annual conference at Southampton on the problems of aircraft production to the theme " The Aircraft Industry—A National Asset." This proposition is being assessed from three points of view, the Lord Sempill lecture by Lord Douglas of Kirtleside being devoted to one of them, " The Operator's Point of View." We expect to record and discuss the proceedings in our next issue, but to-day we are able to publish a suitable introduction to the issues involved, in the shape of a lecture to the graduates and students section of the Royal Aeronautical Society by Mr. Donald W. Douglas, Junior, devoted to " The American Aircraft Industry." Quite clearly, any pronouncement from the president, and son of the founder, of the Douglas Aircraft Company, will command attention, but this lecture was rendered even more valuable by his dealing with questions afterwards—how regrettable it is that, at least in this country, eminent British aeronautical engineers so seldom seem to have an opportunity to present a paper for discussion !

We have reproduced that part of the lecture devoted to the engineering problems facing the aircraft industry in the United States, but some statements even more dramatic in their significance were included in the preceding discussion of the environment of the industry. For instance, in " 1957 approximately 12,000 airplanes were produced—5500 military and 6600 civilian," but for " the financial year 1960, the buying program recommended in the United States budget provides for ordering only 1610 airplanes for the Air Force, Navy and Army combined " and these 1610 cost on average £1,500,000 each ! Nor does the great magnitude of this procurement vote mean that the industry has easy access to funds ; " one manufacturer recently reported that it cost him six hundred thousand dollars to put in an *unsuccessful* bid." The difficulties facing the industry are formidable : the air lines want more economical aircraft in order to attract a vastly larger share of passenger and freight traffic ; the fighting services need far more effective weapons to oppose against the rapidly growing capability of potential enemies ; and the tools to tackle these tasks have to be paid for somehow, despite the facts that the one class of customer expects time to pay, and the other possesses such vast bargaining power that profits can be called, politely, marginal.

It is, perhaps, worth pointing out that it is only by virtue of the industry that Mr. Douglas has described that it is possible for this country to debate whether or not an aircraft industry would be an asset to it : the aircraft industry of the United States has not only provided 86 per cent (by numbers) of the main-line aircraft of the " Western " world, but also contributes importantly to every strategic weapon of that world (both " Jupiter " and " Blue Streak " use North American engines). On that basis many American engineers and some British are inclined to argue that any national aircraft industry which attempts to compete directly with the American industry is wasting effort and money in the attempt to duplicate, necessarily at a lower level of technical achievement, what the Americans have already done. But for ourselves we have no belief in American infallibility, nor, for that matter, in the infallibility of the engineers of any nation. It follows that we think there is not only room for the British aircraft industry to design and build aircraft suited to Britain's own needs and the needs of other European nations which are in some respects dissimilar to American requirements ; but also that that industry should go out to compete more directly with the Americans whenever it seems to its designers that the Americans may have gone astray. It seems to us, indeed, a matter of very great importance for the Western world that there should be aircraft industries here and on the Continent of Europe capable of criticising American designs in that most practical of ways, the building of aircraft better suited than the American for their purposes. It can be done, as the " Viscount " has proved. What should be avoided, if it is humanly possible (which we doubt), is the issue by the Government or the Corporations of specifications more or less certain to result in the production years later of aircraft very similar to and less advanced than American contemporaries.

REPLACEMENT OF THE " QUEEN " LINERS

During the last few years with the two " Queen " liners approaching the generally accepted span of life for large ocean liners there has been speculation about the intentions of the Cunard Steam-ship Company, Ltd. Replacement tonnage will soon be needed to maintain the company's North Atlantic passenger service. The decision put into effect some time ago to fit stabilisers to the " Queen Elizabeth " and then later to the older " Queen Mary " made it appear at that time that both liners were considered to be of a standard of structural and mechanical soundness sufficient to ensure economic operation for a further substantial period, a period, however, which must obviously be limited to relatively few years. Definite consideration is now being given to the replacement problem. That was made evident by questions raised in the House of Commons last week which elicited the reply that discussions were proceeding between the Government and the Cunard Steam-ship Company, Ltd., while this Company is holding consultations with John Brown and Co. (Clydebank), Ltd. On its part, the shipowner has made it clear that the heavy subsidies given, on the score

of national prestige, to its competitors in the North Atlantic service affect the future prospects of maintaining the British Southampton-Cherbourg-New York service.

The technical and economic appreciation of the possible replacement ships and of the service which they should maintain have not been concluded. The company is, therefore, unable as yet to disclose any specific details either of the projected dimensions, passenger capacity or speed of the ships, or whether the form of propulsion will be steam turbine, gas turbine or nuclear. However, there is a pointer that the two-ship service will be continued, since the statement issued by the Cunard Company underlines the success of the voyage results, in terms of both prestige and finance, of the service operated on a two-ship basis instead of the three smaller and slower ships which they replaced.

The replacements will, of necessity, need to be efficient designs, using, of course, modern materials and constructional techniques in order to provide economic ships able not only to compete with subsidised ships but with air transport. The latter has the advantage of being able to call upon large sums of public money at need, and is less concerned with profit or loss so that, peculiarly enough, it can sometimes quote uneconomic fares without having financial qualms. On the other hand, shipping as at present taxed has been unable, since tax computation only takes into account original cost, to make adequate provision for replacement, so that there has been considerable attrition of capital assets. The replacement of the "Queens" will probably cost £20,000,000 or more. Government assistance seems imperative. When one considers the loans recently authorised for the new strip mills as well as the considerable capital made available to the State airways corporations, and the money lent to nationalised industries, then Government participation in the building of new liners is clearly justified. As an added reason, it can be pointed out that although because of the war the two "Queen" liners were not able to start their commercial express weekly service until 1947, the voyage results have been a financial success and the Government building loan has been paid off. Furthermore, the American liner "United States" was subsidised and there is every reason to suppose that the proposed new American liner will also be heavily subsidised, while the liner "France," at present under construction, is being largely financed by the French Government.

On the assumption that operation on the two-ship basis is to be maintained, it may also be assumed that determined by speed-length ratio requirements, the length will approach 1000ft. It may be noted in this context that both the "United States" and the "France" have a length of about 990ft. A number of factors will influence the beam, such as the adoption of aluminium alloy for the superstructures and elsewhere, although the reduction in height of the centre of gravity may be offset by a reduction in machinery weight and the amount of bunkers since advances in machinery design have considerably increased the power/weight ratio and reduced fuel consumption. Again, more compact machinery means smaller machinery spaces, so that there will be more space available for passengers within the main hull, sufficiently perhaps to influence the number of superstructure decks and thus reduce the gross tonnage. Consideration of the above suggests that the beam will in all probability be reduced to a figure more closely approximating to the 108ft 3in of the "France" or the 101ft 6in of the "United States." No doubt, the overall situation will be made clearer with the issue of the Cunard chairman's annual statement with accounts early next month.

SCAPEGOATS ARE NOT HOUSE-TRAINED

Ignorant tribesmen, when any disaster befalls, tend to do two things. They attempt, somehow, to propitiate the gods; and they seek a scapegoat. We are not so very much better to-day. For though science can now explain many of the events that formerly seemed inexplicable, it has not always shown us how to foretell the event or to gain any control of it, even though foretold. Moreover, in our civilisation which is so much more complex than that of the tribe, there is room for inexplicable things to occur—like booms and depressions and inflations and strikes and demarcation disputes—which do not happen in the tribal village. It is true, of course, that nowadays we seldom attempt to propitiate the gods, unless a tendency to avoid passing under a ladder or doing anything important on Friday the Thirteenth, can be called propitiation. For the fact is that to attempt to propitiate the gods is to admit ignorance; and to admit ignorance is rather out of fashion nowadays. But we do seek scapegoats. For to blame somebody for a disaster appears to be to show more knowledge than others as to its causes. We are all very fond of doing it. It flatters the ego. For example, was there ever a strike called by a union executive (or for that matter a shop steward) without somebody claiming that it was Communist-inspired? Unexpectedly, from such a source, Mr. Carron, President of the Amalgamated Engineering Union, found a different kind of scapegoat when addressing the London Students and Graduates of the British Institute of Management last week. "It seems very terrible," he said, "to contemplate that industry needed the threat of war and invasion to move the almost wilful paralysis from the country's productive system and, what is far worse, that the threat to extinguish the ownership of capital caused those responsible to eradicate unemployment overnight." Well! Well! We have had the impression since the war, looking back on pre-war economics, that during the 'thirties, over the face of the world, managements and men were both tragically caught up in a mistakenly managed economic system which nobody properly understood except, perhaps, a few like Lord Keynes crying in the wilderness. The Opposition, whichever party is in power, always, of course, makes a scapegoat of the Government. At this moment, for example, the socialists are laying the blame on the Government for a recession in trade, failing to note that the recession is almost world-wide and far more serious in America than it is in Europe. It is surely much more probable that the cause lies in economic ignorance, abroad as much as here, as to how to marry economic policies in such a way that a currency can be maintained stable whilst output is rapidly expanding. Amongst other scapegoats suggested for the same trouble have been the Americans for mismanaging the dollar or for not raising the price of gold, the Germans for running too large a surplus with the European Payments Union, France for running a deficit with that Union, and a good many others besides.

Even engineers are not immune from seeking scapegoats. It is so much less trouble to lay the blame on somebody else than to seek diligently where the mistake may really be found. When a machine breaks down or something unexpectedly fails do we not all tend at first to attack the operator with "What have you been doing to it?" And even though wholly guiltless, does he not always feel himself on the defensive, lest he be attacked? How many designers faced by a series of failures of a particular kind of machine, and having checked and rechecked calculations without finding any fault have been driven, rather than to admit abysmal ignorance, to

declare that some enemy hath done this, it must be lack of care on somebody's part, or even sabotage, no doubt at the instigation of evil competitors ! No wonder, last week, at the close of this year's Leonardo da Vinci lectures at the Mechanicals, Sir Frank Mason stressed to the schoolboys and schoolgirls present that to be successful in engineering one must have integrity, courage and humility. He is abundantly right. Integrity is essential lest an engineer should try to conceal it from himself as well as from others whenever he discovers a mistake in his own work. For no man learns much if he cannot learn from his own errors. Courage there must be in plenty, if only to confess to error and to force a limp and drooping ego to try again. Humility, too, is needed so that it can be accepted that any failure is much more likely to have arisen from one's own ignorance or misjudgment or misdirection of a junior than from the wilful action of anybody else of whom one can make a scapegoat. The fact is that scapegoats are not house-trained. They are deceitful. They do not make good pets. They should be turned away from the doors of the mind and never allowed inside.

SELLING OVERSEAS

On page 616 we summarise a report entitled *Export Trade Facilities* which has been prepared by a working party, appointed a year ago by the Federation of British Industries, under the chairmanship of Sir Cecil Weir. The working party was set up after talks between the F.B.I. and the Board of Trade had indicated that there might be some " gaps " in the facilities available for assisting British exporters. Accordingly, the working party's terms of reference were very broad ; the " facilities for export " involve every aspect of the export process and every aspect of that process is important. The working party, however, concentrated its attention mainly on education and training for salesmanship and on information and trade promotion schemes which are obviously essential to the task of extending this country's overseas markets. The United Kingdom's post-war export performance has been outstanding and the contribution made annually by the engineering and allied industries has been even more outstanding. But in the last year or so, with a chill breeze of trade depression being felt in various countries, export business has tended to shrink in some sectors, though, we are confident, there is no serious shrinking in the efforts of British exporters. British industry is not likely to become complacent about exports ; it is only too well aware that its share in the world export of manufactured goods is falling and that competition from other countries is intensifying.

There has been no shortage of exhortation from Government and many other organisations and individuals about the need for this country to export if it is to survive. Sometimes, in fact, there may have been so much exhortation that industry has grown just a trifle weary of it ! Nor has there been any serious lack of what may be appropriately called aids to exporters. The Board of Trade, trade associations, market research organisations, and specialist bodies like the Dollar Exports Council have for years been operating at full stretch in their respective spheres with the object of furthering this country's export effort. Nevertheless, there are potential exporting concerns which are still not very familiar with the facilities available to them and there are still some ways in which those facilities could be extended or improved. That really is what the F.B.I. working party has been examining and the conclusions and recommendations set out in its report are deserving of careful study. The report emphasises the importance of education and training for export management and marketing, commenting, in this context, that the full benefit of improved technological education leading to greater productivity will not be derived unless there is corresponding advance in marketing. There is similar emphasis on the subject of market investigation and on the most effective methods of export trade promotion. Under this latter heading, the working party has something to say about trade fairs and exhibitions. This presents a problem which is not new but which now needs more than ever to be clarified and satisfactorily resolved in order that British goods may be effectively displayed and demonstrated to likely overseas customers. But when all is said, it remains obvious that one of the best ways of increasing the country's exports is by encouraging a greater number of firms to become competent exporters. The working party stresses this fact early in its report. It urges those manufacturers who may regard export business as a " fluctuating over-spill " to look more keenly upon overseas territories as an integral part of their total market. That is wise counsel from which small firms as well as large can benefit.

The Engineer—100 Years Ago (APRIL 15, 1859)

" STREET RAILWAYS "

" The construction of the London Bridge and Charing-cross and the Metropolitan Railways promises to become the first step to a general improvement of the metropolis. The former will change the whole course of a large part of the City and West-end traffic, whilst it cannot fail to stimulate, to a considerable extent, the entire internal communication of London. More than this, this railway will demonstrate the practicability and value of great metropolitan improvements. No one can pretend that the present thoroughfares of London are adequate to the accommodation of its commercial wants. The traffic upon London Bridge, perhaps the most crowded of our thoroughfares, is almost incredible, and far beyond anything ever contemplated by the builders of that noble structure. It has been well said that nothing but the most perfect combination of skill and authority would suffice to keep that great artery open for five minutes together. An average of twenty-five carriages pass over it in every minute between 9 a.m. and 6 p.m., or 13,500 in that portion only of the day. At times, this average is more than doubled. . . . . The traffic is always growing ; every year brings an increase. The streets do not grow, and are already full, indeed overcrowded with traffic.

" Whoever has paid attention to the subject of street railways must have seen that a much larger number of passengers can be carried upon them within a given space and with a given amount of power than by any ordinary roadway carriages. Street railways have not received their due share of attention in London, partly because the ordinary public were unused to them and were apprehensive of difficulties which never arise in the working of street railways in other cities ; and partly because engineers, lawyers and such others as are generally foremost in promoting new schemes, could discover little chance of gain from such railway beyond their legitimate commercial profits."

ENGINEERING, MARINE, WELDING AND NUCLEAR ENERGY EXHIBITION

No. II—(*Continued from page* 567, *April* 10)

THE Engineering, Marine, Welding and Nuclear Energy Exhibition was opened yesterday, April 16, at Olympia and will be open daily until Thursday, April 30, next. In this, our second article on the Exhibition, we give particulars of some more of the plant exhibited.

Hydraulics and Pneumatics, Ltd.

A recent addition to the hydraulic and pneumatic equipment marketed by Hydraulics and Pneumatics, Ltd., Villiers Street, Wolverhampton, is the automatic variable delivery, constant pressure pump we illustrate in Fig. 13. This rotary pump is designed to deliver fluid at pressures from 500 lb to 2500 lb per square inch and thereafter maintain the required

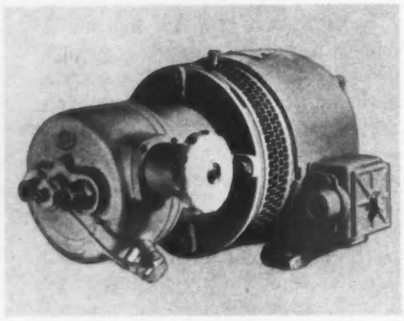


Fig. 13—Automatic variable delivery, constant pressure pump—Hydraulics and Pneumatics

pressure in a hydraulic system. The basic pump construction is shown in the drawing, Fig. 14. Its rotor revolves on a stationary ported valve and has seven radial bores, in each of which there is a piston with a slipper attached by a cross-pin at its outer end. These slippers press on a track ring mounted in the pump casing eccentric to the ported valve. This ring causes the pistons during each revolution to make one pressure and one suction stroke, and it is pivoted in the pump casing. The position of the ring in relation to the central ported valve is controlled by a small hydraulic plunger in communication with the pressure circuit and acting against a spring, the compression of which can be varied by a handwheel.

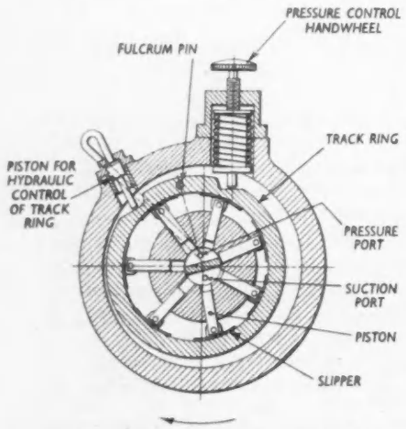


Fig. 14—Arrangement of automatic variable delivery, constant pressure pump in full stroke position—Hydraulics and Pneumatics

In operation, the pump gives the full output of fluid until a pressure in the circuit is reached when the spring load is balanced by the oil pressure on the plunger. Any further tendency to build up pressure in the circuit serves to force the track ring over to the zero piston stroke position. If the output from the pump is shut it ceases to deliver and the track ring assumes a setting where only a sufficient volume of oil is delivered to make up any leakage or loss.

Any tendency for the pump to heat up when idling at full pressure is prevented by the provision of a circulation of cooling oil throughout the casing. Due to the action of the rotating parts of the pump, oil drawn in through the suction port in the pump casing deflects the revolving oil from the casing back into the tank. Thus, a continuous circulation of oil at low pressure is set up which keeps the pump cool. When the pump is delivering pressure oil and the necessity for cooling no longer exists, there is a corresponding reduction in this circulation.

There is also exhibited what is called a " Hi-Lo " pump for use in installations where a quantity of oil is required at low pressure. This pump consists of a 2½ h.p. double-spindle motor with a low or medium pressure gear pump at one end and an automatic variable delivery pump at the other end. The gear pump supplies the large volume of low-pressure oil required and then the unit automatically changes over to introduce into the system a small volume of high-pressure oil at up to 2500 lb per square inch from the other pump.

There are exhibited on the stand examples of the actuators recently introduced by the firm and described in our issue of March 20 last. Also of interest there is a package unit incorporating vacuum pump, vacuum tank and electric motor with a variety of face plates mounted on universal clamps. By this equipment, articles which are easily distorted, fragile, non-magnetic or of awkward shape, can be readily held by means of vacuum. Additionally there can be seen a vacuum pencil for holding small intricate articles during assembly, such as in the electronics or watch-making industry, and a screwdriver for the insertion of screws in places not readily accessible.

Self-Changing Gears, Ltd.

In addition to examples of its well-known rail and industrial control and power transmission equipments, the firm of Self-Changing Gears, Ltd., Lythalls Lane, Coventry, is showing the oil operated marine gearbox with sequent control illustrated in Fig. 15. This gearbox, which transmits full engine power ahead or astern as required, is designed for unit construction with the engine. Its clutches are self-adjusting and, to ensure that the propeller is stationary when the controls are in the neutral position, there is fitted a brake actuated by oil pressure from the lubrication supply.

The firm's air operated " RF28 " railcar and locomotive final drive and reverse unit on show has a hinged top to enable inspection of the mechanisms. Exploded models are also shown of a fluid friction clutch and a Schneider single stage torque converter.

A more recent addition to the transmission equipment made is a compact clutch and reduction gear suited to marine applications, which is shown in Fig. 16. This unit consists basically of a plate " over-centre " type clutch mounted on a central shaft,

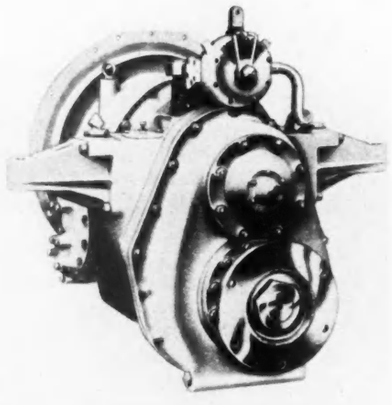


Fig. 15—Oil operated marine gearbox with sequent control—Self-Changing Gears

provision being made for a fixed reduction unit to be fitted. The gear ratio range available extends from 1·5 : 1 to 6 : 1 and the direction of rotation of the output shaft can be either clockwise or anti-clockwise, as required. The operation of a manually operated lever on the outside of the clutch housing brings into engagement a twin or single plate clutch to transmit engine torque.

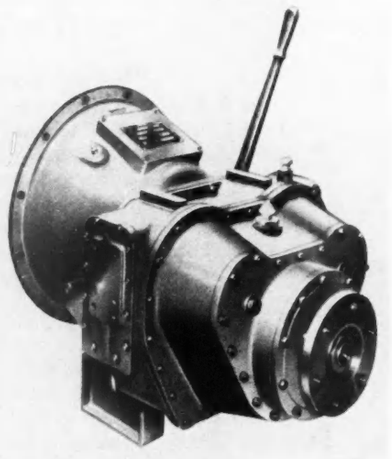


Fig. 16—Twin plate clutch and reduction unit—Self Changing Gears

John Thompson, Ltd.

Visitors to the nuclear power plant section of the stand of the John Thompson group of companies find of particular interest the details of the fuel loading and unloading equipment for the Berkeley nuclear power station which is sectionalised into manufactured assemblies, scale models and diagrams. One item of plant shown is the top 27ft of the 50ft high fuel chute. In this assembly the pressure vessel contains the top portion of a three-channel rotatable magazine and the winding gear with two wire cables to support the chute lifting grab. A differential gearbox outside the top section is designed to ensure that the main cable of the chute carries a load ten times that of the secondary, or emergency, cable.

Also passing through the top section and through the pressure-sealed glands, are drives to connect or disconnect the grab from a load, and to position latches used in the magazine channel to support and clear the various chutes. Through a pipe at the top of the assembly the machine is cleared of air and filled with CO_2 gas before the machine is connected to the reactor vessel.

The 4ft diameter magazine, displayed, is an integral part of the fuel charge/discharge machine and enables a full load, sufficient for one reactor fuel channel, to be carried in the machine. This magazine is automatically indexed and, in the case of a discharge machine, produces an empty pocket for each of the thirteen exhausted fuel elements which it collects from a reactor vessel fuel channel. When forming part of a charge machine, the magazine carries a fresh, new fuel element to refill a channel of a reactor vessel. Indexing of the magazine, each of whose twenty pockets are fitted with a stirrup-shaped latch on which fuel elements can rest, is by Geneva mechanism to ensure accuracy in positioning. Only when there is no weight on a latch and its pocket is in line with the grab, can the latch be freed to allow a clear passage down into the reactor vessel.

Fitted on top of a differential gearbox and taking its drive from it, is the fuel machine's discriminator unit. This unit, by discriminating one against the other, enables a magslip transmitter continuously to indicate, on the machine control panel, the length of stretch of the main cable. By these means, a reliable estimate of the length of the main cable's life is always available. By employing a second magslip transmitter to the control panel, the discriminator gearbox indicates the actual position of the grab inside the chute machine, so that the grab can be stopped automatically at various predetermined operational positions. We are informed that in designing and making this discriminator gearbox, degrees of accuracy comparable with those needed in the production of guided weapon control systems were necessary.

The position of the exhibited equipment in relation to the reactor face at Berkeley is shown diagrammatically, as also are the flux scanning winches, which are being made by the John Thompson Ordnance Company.

A John Thompson-Wilson "Multipac" package boiler exhibited has an evaporation capacity of 5500 lb per hour. This design of steam-raising plant is easily and quickly convertible into a solid fuel or an oil-fired boiler and is made in eleven sizes with capacities from 2500 lb per hour to 18,500 lb per hour. The wet-back combustion chamber fitted dispenses with the necessity for refractory linings, the chamber's adequate volume being obtained by a dished-end design. This form of construction also reduces the number of stay bolts, and additional support is given to the combustion chamber by its cleaning door and the soot-blower supports. Two passes of fire tubes are arranged below the flue with clear water space above, similar to an Economic boiler, and the "Multipac" has independent tube plates.

The draught fan is placed on top of the front smokebox, and by having the ducting to the burner incorporated inside the smokebox, additional advantage is obtained in that the intake to the fans is above the boiler and not, as usual, at floor level. A fully modulated rotary-cup burner is capable of burning all types of oil fuel up to and including 3500 seconds Redwood No. 1, and it operates without a pumping and heating set.

Yates Plant, Ltd.

To facilitate and speed the work entailed in welding large fabrications, Yates Plant, Ltd., Whidborne Street, London, W.C.1, has developed a travelling universal welding column and boom through which an automatic welding head can be accurately positioned and controlled. This equipment is mounted on a motorised trolley which runs on standard gauge rails along the shop floor and can be driven in either direction at welding speeds from 6in to 76in per minute. A rapid traversing speed of 16ft per minute is available for positioning purposes.

A turntable mounted on this trolley supports a double pillar column through a

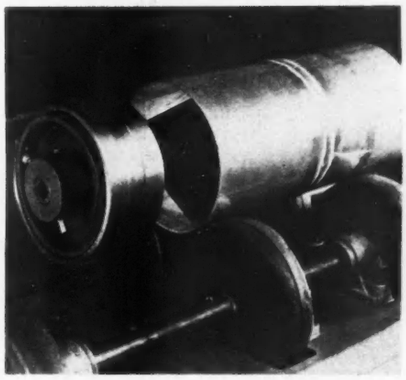


Fig. 17—Continuous backing bar and clamp for cylindrical vessels—Yates

powered turntable which can be rotated at 0·315 r.p.m. in both directions. A crosshead or saddle carried on the column is counterbalanced and can be raised or lowered at speeds from 10in to 150in per minute to the maximum height of 40ft on the column. This crosshead supports a retractable boom which has a traverse of 17ft in the saddle and has at its end a welding head at the side of which an operator can sit or recline in a cockpit from which he has an unobstructed view of the welding operation. All movements of the machine can be controlled from the operator's cockpit, and, if a manipulator or rotator is used for supporting the work, its controls are duplicated at the operator's station.

This firm has also developed a new continuous backing bar incorporating an internal expanding clamp for welding work on pipes and cylinders. The backing bar is made in sizes for work from 4in to 10ft diameter and enables the alignment and secure clamping of two cylindrical components for welding purposes. One of the bars is shown in Fig. 17 and it consists of a cylinder formed by a closely coiled helix. Torsional means are provided to tighten the coil and decrease the external diameter, so that the bar can be easily inserted into abutting pipe lengths and located where they meet. When in position, the tension is released and the bar expands to a size equal to the internal diameter of the work. The diameter of the bar is then increased mechanically to clamp the work-pieces firmly together for welding. Expansion or contraction of the backing bars can be effected manually or mechanically in accordance with their size and the class of work.

Keith Blackman, Ltd.

The extensive range of fan equipment displayed upon the stand of Keith Blackman, Ltd., Mill Mead Road, London, N.17, includes examples of the recently introduced "Aristocrat" centrifugal fans. These fans, which have a low sound level in operation, are suitable for heating and ventilating applications, air conditioning and general ventilating work. They are at present available in a capacity range up to 9000 cubic feet per minute at 3·5 w.g.

Representative of the large fans made by the firm is a 70in impeller with backward swept aerofoil section blades, stated to provide efficiencies of up to 90 per cent. This fan is used for induced draught, air conditioning and mine ventilation purposes and handles large air volumes against moderately high resistances.

The marine fans shown include a 23in diameter axial fan for ventilation purposes and a pivot roller axial fan designed to give the high degree of accessibility which is essential to marine applications. This accessibility facilitates routine maintenance and is made possible by the large access doors which form an integral part of the fan case.

The industrial gas equipment shown by the firm includes well established gas burning and controlling equipments including injectors, burner heads, governors, valves and air/gas compressors.

Fawcett Preston and Co., Ltd.

The Grier-Mercier hydro-pneumatic accumulator is now made in a number of sizes by Fawcett Preston and Co., Ltd., Bromborough, Cheshire, for pressures up to 5000 lb per square inch and capacities from 10 cubic inches to 8 gallons of either water or oil. This design of accumulator is basically a fluid pressure storage chamber in which the potential energy of a fluid under pressure is stored against a compressible gas contained in a synthetic rubber bag. The alloy steel shell of the accumulator has a liquid discharge port fitted with a spring-loaded poppet valve in its base. The rubber bag has an air valve moulded in it for charging with air or nitrogen from an external supply.

The way in which this design of accumulator can be used to smooth out pressure surges and prevent line shock is shown on the stand with a shock absorption rig. In this rig the hydraulic shock produced by the impact of a falling weight is recorded on an oscilloscope screen. When an accumulator is connected into the hydraulic system it is shown that the shock is virtually eliminated.

Other equipment shown by this firm includes, amongst a range of hydraulic valves, one which automatically isolates sensitive pressure gauges and instruments in hydraulic systems. When the pressure in a system fitted with one of these valves rises

above the preset limit it closes the supply to the instruments and again reopens when the pressure falls. The valve can be adjusted to operate between 50 lb and 4000 lb per square inch.

Ruston and Hornsby, Ltd.

A number of new exhibits are on view in a joint display by Ruston and Hornsby, Ltd., and its associate company, Davey, Paxman and Co., Ltd. The group's stand is divided into two main sections, one being occupied by water cooled and the other by air cooled engines. In the former section

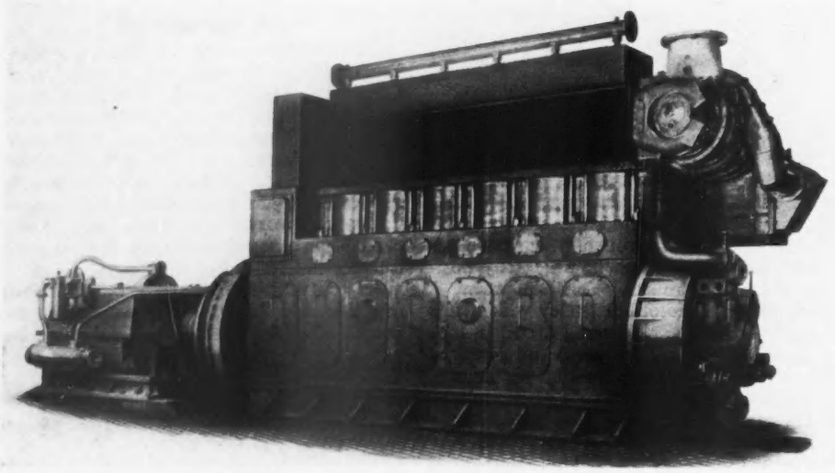


Fig. 18—" 6 ATC " marine engine of 950 continuous s.h.p.—Ruston

will be a Ruston " 6ATC " engine and a Paxman " Ventura " unit, while in the latter section, among the air cooled engines, will be a Paxman " Vega."

The pressure charged and intercooled " 6ATC " engine, illustrated herewith, is representative of the new Ruston medium-speed diesel range covering 705 to 1685 b.h.p. in five sizes of from five to nine cylinders. This engine has a bore and stroke of 12½in by 14½in, giving a swept volume of 1785 cubic inches and a piston speed of 1200ft per minute at 500 r.p.m. The brake mean effective pressure is 160 lb per square inch and the cylinder pressure 1200 lb per square inch, while fuel is injected at 2500 lb per square inch. Castings are largely employed in the construction of the engine and separate cylinder heads each carry two inlet and two exhaust valves. The cast iron pistons are oil cooled and have three pressure, one triple seal and two scraper rings and a shallow bowl-shaped crown. Connecting rods of forged steel having a chilled bronze small end bush and twin steel-backed aluminium-tin big end bearings are fitted, and similar bearings carry the forged steel crankshaft formed by the " Continuous Grain Flow " process, and fitted with balance weights. Fuel oil is delivered to multi-hole injectors by pumps arranged one per cylinder. A description of the engine appeared in THE ENGINEER of March 6.

Of direct injection, pressure charged and intercooled design, the Paxman " 12Y.V.C." " Ventura " engine has an open combustion chamber, a bore of 7½in, a stroke of 8½in, a firing pressure of 1250 lb per square inch and speed of 1500 r.p.m. The cylinders are set at 60 deg. and the engine has a high power to weight ratio and a brake mean effective pressure of 154 lb per square inch. Fabricated construction has been adopted for the crankcase and cylinder blocks and the cast aluminium alloy cylinder head has two inlet and two face-hardened exhaust valves. The forged steel cylinder liners are chromium-plated. Three compression and two oil control rings are fitted to the aluminium alloy pistons and the fork and blade pattern connecting rods are forged in high tensile steel, while the crankshaft is of forged nickel-chrome high tensile steel and supported in thin shell copper-lead-lined main bearings. Monobloc C.A.V. fuel injection pumps are provided for each cylinder bank.

Fig. 19 shows the twelve-cylinder, 90 deg. " V " form, air cooled " Vega " engine of 6in bore by 6·6in stroke, a 15 to 1 compression ratio and a continuous rating of 400 b.h.p. at 1800 r.p.m. The crankcase is of spheroidal graphite iron and the individual cylinder heads and barrels are one-piece aluminium alloy castings fitted with shrunk-in hardened cast iron liners, and one inlet and one exhaust valve. Four pressure and two oil scraper rings are fitted to the aluminium alloy piston and the forged steel underslung crankshaft is carried in steel shell copper-lead-lined and lead-tin-flashed bearings. C.A.V. fuel injection pumps are mounted and the axial cooling fan delivers 30 cubic feet of air per brake horsepower at 7in w.g. A more detailed description of the " Ventura " and " Vega " appeared in our issue of February 13.

W. H. Dorman and Co., Ltd.

Several new engines are on view on the stand of W. H. Dorman and Co., Ltd., Stafford, in addition to a complete range of the company's " L " diesel engines. To the " LB " series of units has been added two mark " LC " engines, which have six cylinders in line and are available either normally aspirated or turbo-charged, and a " 6 LCT " engine is shown in Fig. 20. Compared with the established " LB " unit the " LC " engine has a bore opened out from 125mm to 5in and a stroke increased from 130mm to 5·875in to increase the swept volume from 584·4 to 692 cubic inches. The running range is 1800 r.p.m. continuous up to 2200 r.p.m. intermittent duty and at 1800 r.p.m. the " 6 LB " develops 136 b.h.p., the " 6 L C " 160 b.h.p. and the " 6 LCT " 200 b.h.p. The compression ratio is 16 to 1 in the normally aspirated engine and 14 to 1 in the turbo-charged unit. The crankcase of cast iron is integral with the cylinder jackets to which chromium plated liners are fitted. Three bores are covered by

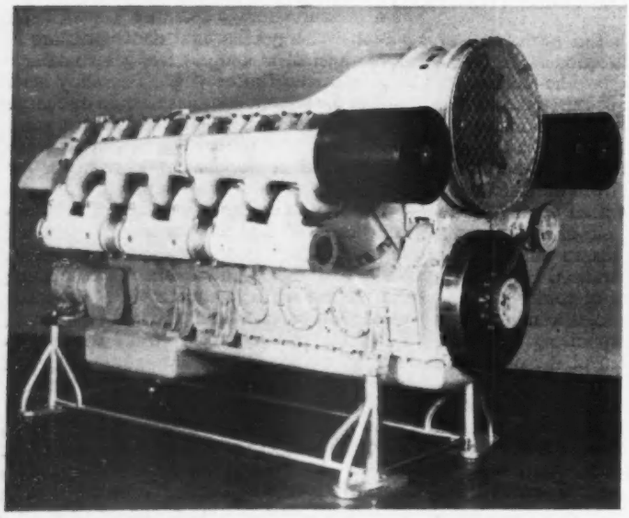


Fig. 19—Twelve-cylinder " Vega " engine of 400 b.h.p. at 1800 r.p.m.—Ruston

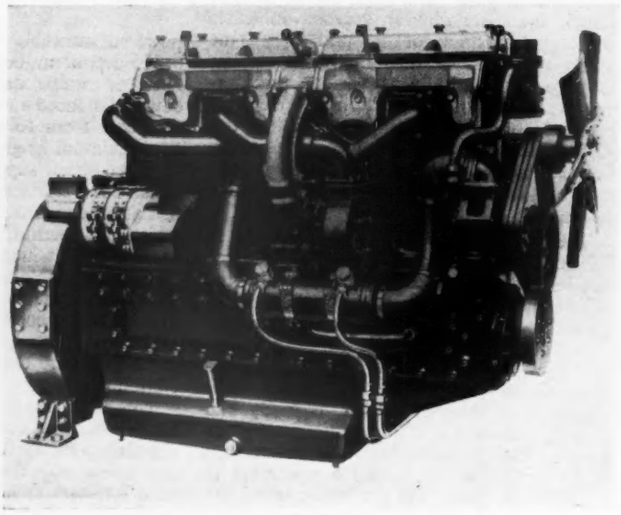


Fig. 20—" 6 LCT " engine of 200 b.h.p. at 1800 r.p.m.—Dorman

each high duty iron cylinder head and at each cylinder there is one exhaust valve and one masked inlet valve, both valves having detachable seat inserts. A gear driven camshaft, mounted high up in the crankcase, operates the valves through rocker arms, which are En.32B steel stampings, tubular push rods and cast iron chill faced bucket tappets.

Aluminium alloy pistons having toroidal cavity combustion chambers, three compression and two scraper rings are used, with connecting rods of En.12 Q material and having a small end bush of silicon bronze. A Holset viscous damper is fitted to the free end of the counterweighted and dynamically balanced underslung crankshaft which is an En.19S stamping carried in thin wall steel copper lead lined bearings, there being similar big end bearings. Oil fuel is delivered to C.A.V. nozzles, in holders set at an angle of 25 deg. under the aluminium rocker cover, by a C.A.V. "N" fuel pump through twin parallel flow Purolator filters. Triple element parallel flow filters of the same make are fitted in the lubricating oil system. Turbocharging is by a single B.S.A. Mark "C" unit mounted on the exhaust manifold.

The "Q" series of engines has been enlarged by the addition of the eight-cylinder unit which is shown on the stand. This is a direct injection four-stroke, 90 deg. formation water-cooled engine having the same bore and stroke, namely 6¼in by 6½in, as the six-cylinder in-line engines, and is available normally aspirated or turbo-charged. High duty cast iron is used for the combined crankcase and cylinder unit and there are separate cylinder heads of high-grade iron alloy. Detachable wet liners centrifugally cast in high-grade iron and chrome hardened in the bore are fitted, and the aluminium alloy pistons have three pressure and two scraper rings of cast iron and a toroidal cavity in the crown. A side by side connecting rod arrangement is adopted, the connecting rods being stampings in En.16T, and having a silicon bronze gudgeon pin bush and big end bearings of thin wall, prefinished steel-backed copper lead lined pattern. Similar bearings carry the induction hardened crankshaft which is an En.19S forging fully machined and counter-weighted and fitted with a 14in Holset viscous damper. Valve guides are of hardened and tempered iron alloy and there is one inlet and one exhaust valve per cylinder, the valves being Stellite faced and tipped and the exhaust valve stems being chrome flashed. Detachable prefinished valve seat inserts of high chromium iron are employed.

There are two camshafts mounted high up on the inside of the Vee and also two tandem-driven four element Simms fuel injection pumps, on one of which is mounted a diaphragm lift pump. The fuel passes through a twin parallel flow filter and is delivered to nozzles having four holes and a cone angle of 150 deg. The lubricating oil pump is mounted on the rear main bearing cap and the oil passes through a triple element parallel flow filter, while a gear driven pump circulates the coolant through the cylinder jackets and heads. In the cooling system are twin parallel flow thermostats. The turbo-charged engine is fitted with a single B.S.A. 24 turbo-charger, and in this form the "8QVAT" unit develops 455 b.h.p. at 1800 r.p.m. The engine has a compression pressure of 480/600 lb per square inch and a maximum firing pressure of 1000/1100 lb per square inch naturally aspirated and 1300/1400 lb per square inch when turbo-charged.

George Ellison, Ltd.

New switchgear shown by George Ellison, Ltd., Perry Bar, Birmingham, 22B, consists of an 11kV, 250MVA circuit breaker unit (ASTA certified to BS 116 : 1952) and an 11kV, 250MVA, oil switch (ASTA certified to B.S. 2631 : 1955) suitable for controlling the ring main supply to the circuit breaker. This equipment was described in our issue of March 13, 1959, page 423. A typical switchboard embodying these units is illustrated in Fig. 21. This particular installation consists of two circuit breaker cubicles and two switch cubicles. The circuit breaker unit on the extreme left controls a 750MVA transformer. Next (with the cubicle door open) is another circuit breaker, to control a 600 h.p. motor. The two units on the right control the ring main supplies to the busbars.

Fig. 21—Switchboard with (left to right) two circuit breaker cubicles controlling, respectively, a 750kVA transformer and a 600 h.p. motor and two oil switches controlling ring main supply to the busbars—Ellison

The circuit breaker is oil filled, designed to interrupt 400A, and is vertically operated by a handle-operated "single" screw mechanism, the "live" plugs being sealed off by shutters positively driven in both directions.

The circuit breaker can be closed manually by a trip-free handle or by charging and releasing a spring, the speed of closure being independent of the operator. Closing may also be remote, by releasing a hand-charged spring, by a d.c. solenoid or a lanyard, or the circuit breaker may be power closed with a d.c. solenoid.

The oil switch has a normal current carrying capacity of 400A, a breaking capacity of 400A and a making capacity of 250MVA. It is manually operated by charging and releasing a spring with one movement of the handle, both "making" and "breaking" being independent of the operator. High-pressure line contact blades give a single break per phase. Both the circuit breaker and the switch are equipped with comprehensive safety interlocks.

The busbars (1200A rating) are air insulated and covered with an epoxy-resin-based "Tufnol." To simplify installation the busbars are of standard unit length; the busbar chambers are individually sealed off.

Southern Instruments, Ltd.

The Sigrist and Weiss photometer (Fig. 22) which is now available in this country is being shown by the agent for this instrument in the United Kingdom, Southern Instruments, Ltd., Frimley Road, Camberley, Surrey.

This photometer (UP21D) is designed for the continuous measurement and control of turbidity and absorption. It operates on the principle of the continuous comparison of two light beams, emanating from the same source, and measured by the same photo-electric cell. An oscillating mirror directs the light beam alternately between a test cell and a comparison standard. If the light intensities received via the two paths are unequal, an alternating voltage will be produced by the photo cell; when amplified this voltage will be used to drive a motor and move a diaphragm in such a sense as to equalise the light arriving at the photo cell from each path. In this system the complete output of the single light source is alternately passed down each light path to give maximum available sensitivity. The measured value is determined solely by the equalising diaphragm and the structure of the light path and is therefore unaffected by fluctuations in the light source, alterations in photo-cell sensitivity and amplifier drift.

A direct reading of absorption or turbidity is given on a measuring drum coupled to the

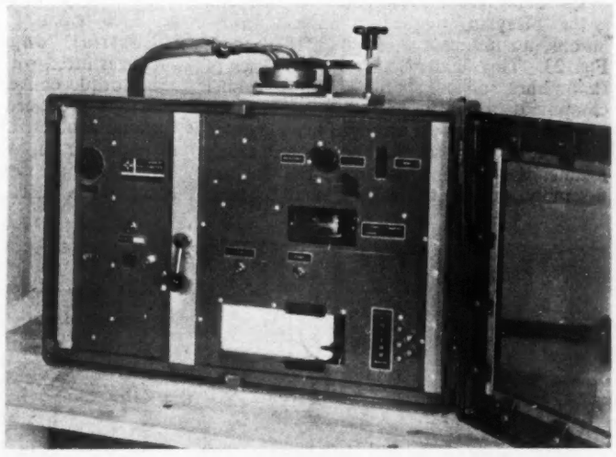


Fig. 22—Sigrist and Weiss industrial photometer for continuous measurement of turbidity and absorption—Southern Instruments

equalising diaphragm, and a built-in inkless recorder is provided. Remote operation of other recorders or remote control of the process under investigation can be effected by potentiometer attachments to the measuring drum shaft. Suitable potentiometers can be supplied with a d.c. source, as optional extras.

Provision is also included for the closure of internal contacts for alarm initiation at predetermined maximum or minimum levels.

Absorption and turbidity measurements are carried out by means of a wide variety of flow cells having various path lengths and kinds of finish for corrosive liquids and gases. True turbidity (nephelometric) measurements are given by the scattered light reading and not transmission loss. Filters can be inserted for absorption measurements over narrow bands.

Typical applications involving absorption are in the control of decoloration in the manufacture of sugar and edible oils and colour control in oil refineries. Applications associated with turbidity include filtration efficiency in water supply, effluent control and the control of various processes in brewing.

Silentbloc, Ltd.

On the combined stand of Silentbloc, Ltd., Manor Royal, Crawley, Sussex, and its subsidiary, the Andre Rubber Company, Ltd., there will be seen examples of the many applications of rubber bonded to metal components in all industries. These applications range from miniature "Silentbloc" units for mounting delicate instruments to large flexible bearings and couplings.

The most recent development of this firm is the "Raykin" fender for harbour installations, an impression of which is given in Fig. 23. This fender consists of a series of sandwiches of a special natural rubber compound set between steel plates. The assembled sections are arranged in an inverted "V" formation so that any force acting against the fender tries to flatten out the assembly, putting the rubber sandwiches in shear. The resistance of the fender produces a gentle cushioning action that absorbs energy at a very high rate, eliminating risk of damage to hull plating and harbour installations.

There are no parts in the fender which can jam, and it requires the minimum of maintenance during service. Its components are virtually unaffected by corrosion, rotting or ageing as, in addition to coatings of primer, multiple coatings of Neoprene are applied to the metal parts, whilst the assembly bolts, nuts and washers are cadmium plated. Each fender is supplied as a complete assembly so that installation to pier structures is simple, rapid and inexpensive.

Saunders Valve Company, Ltd.

Diaphragm valves for all branches of industry are now made in a wide range of sizes by the Saunders Valve Company, Ltd., Cwmbran, Mon, and a number of sectioned models on this firm's stand are being used to demonstrate the simplicity of their design and ease of maintenance. Examples are included of the firm's manually-operated and remote controlled full bore valves which can be arranged for pressure opening, piston-operated pressure closing or high-pressure closing heads. A new sliding spindle bonnet assembly has been introduced for valve users who wish to employ their own operating mechanism. Amongst the plastic valves exhibited there is shown a spherical plug valve now being made in eight sizes from ½in to 3in, and which can be supplied with nylon coated plugs if required.

A number of the centrifugal pumps made by the company's "Safran" pump division include a new glandless, wet motor circulator for domestic small bore central heating systems.

Leyland Motors, Ltd.

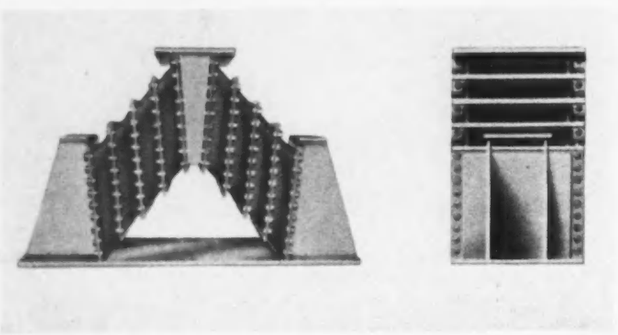
Several engines manufactured by Leyland Motors, Ltd., Leyland, Lancashire, on view include a UE250 four-cylinder industrial engine, shown with a 12in three-element, single-stage torque converter giving a multiplication of 3 to 1. With a bore and stroke of 4·1in by 4·75in, the direct injection unit has a maximum rating of 72 b.h.p. at 2200 r.p.m. and a maximum torque of 190 lb-ft at 1300 r.p.m. The six-cylinder UE350 industrial engine shown is fitted with a 13in torque converter which is produced by Leyland Motors, Ltd., in conjunction with Self Changing Gears, Ltd., and is based on the Schneider system. The engine has a 3·96in bore by 4·75in stroke and a maximum rating of 98 b.h.p. at 2400 r.p.m., and a maximum torque of 255 lb-ft at 1400 r.p.m.; cast iron is used for the monobloc cylinder and crankcase and the balanced crankshaft has nitrided wearing surfaces. Fuel supply is by a Simms fuel injection pump and all moving parts are pressure-lubricated from a wet sump, while the cooling system is thermostatically controlled.

Also to be exhibited is a sectioned model of a standard EO375 power unit, and a self-contained power pack having a six-cylinder unit developing 165 b.h.p. at 2100 r.p.m. and fitted with a 16in Self Changing Gear single-stage torque converter. The Auto Diesel generator on view incorporates an O.900 engine, which produces 176 b.h.p. at 1500 r.p.m., and a generator delivering 50 or 60 c/s, three-phase current at 230V or 400V and rated at 145kVA at 0·8 p.f.

Another exhibit, seen in Fig. 24, will be the Ajax "Argonaut," which is the largest of the marine propulsion units and is a six-cylinder, direct-injection, four-stroke engine having a bore and stroke of 5½in by 6½in. It is equipped with a Simms Eberspacher turbo-supercharger and has an output of 206 b.h.p. at 1600 r.p.m. at the continuous twenty-four-hour rating and 240 b.h.p. at 1700 r.p.m. at the twelve-hour rating. The drive is through a Self Changing Gear MRF16 hydraulically controlled gearbox and the maximum installation angle for the engine is 1 in 7.

Decca Radar, Ltd.

On the stand of Decca Radar, Ltd., Albert Embankment, London, S.E.11, is a complete Decca D.7 series consisting of seven marine radars of which two will be fully installed and working. The sets are in three groups and in group one are the Mark D.303, D.404, D.505 radars, each employing a 9in display unit and transmitter powers of 10kW, 20kW and 75kW respectively. They are designed for use where both space and the power available are limited. Mark D.606 and T.M.707 radars form group two, and both employ 20kW transceivers and a 12in P.P.I. display unit, while the second set contains both true and relative motion facilities. These sets are intended for high-class tonnage, while the group three units, D.808 and T.M.909, are designed to give exceptional performance. Both radars have 12in P.P.I. display units and transceivers, with a nominal output of 75kW. All sets have printed circuits and a 6ft aerial of new design, except the D.303, and all except the D.303 have a range of 48 miles. A fuller description of the series appeared in our columns of November 14, 1958. In addition to the D.7 series, the company will be showing its marine automatic plotter and marine Dectra equipment, together with survey equipment in various forms.



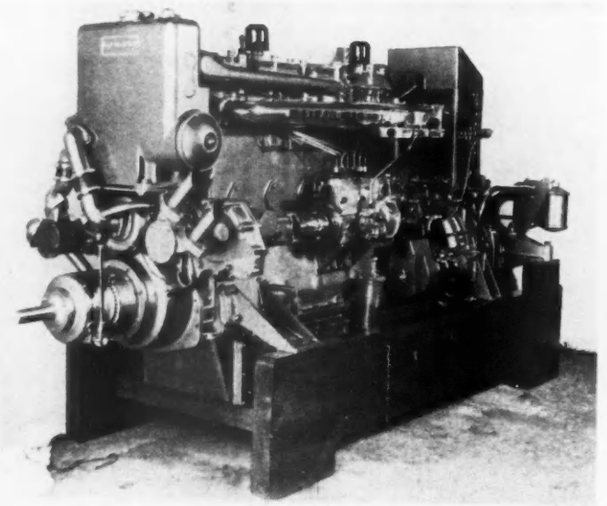


Fig. 23—"Raykin" fender for harbour installations—Silentbloc

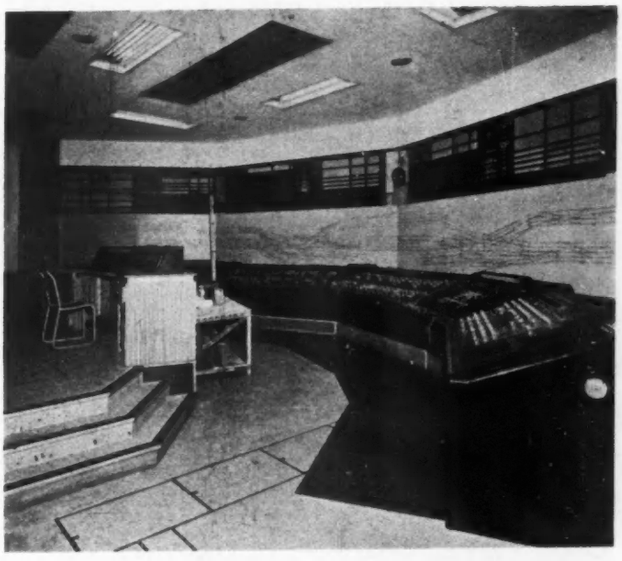
Fig. 24—Ajax "Argonaut" turbo-charged engine, 206 b.h.p. at 1600 r.p.m.—Leyland

(To be continued)

Resignalling at Newcastle

No. I

The new route-relay interlocking brought into service on Sunday, April 12, 1959, at Newcastle, is one of the largest in the world. Due to the intensity of the traffic particular care had to be paid, in designing the installation and programming the change-over from a notable electro-pneumatic plant of 1906 controlled from three signalboxes, to provide a " one-box " plant on the most modern lines.



THERE must be few large centres of railway traffic that in successive stages present the historical development of British railway signalling practice more clearly than the Central Station at Newcastle upon Tyne. The new route-relay interlocking plant brought into service on Sunday, April 12, 1959, is a fine example of modern technique, and the significance of its general conception and details will be the more appreciated from a preliminary reference to the noteworthy plants that preceded it—outstanding in their day, and putting the arrangements for traffic working at Newcastle well ahead of the general standards prevailing in this country. The new installation brought into service at the beginning of this week is not to the same extent a pioneer, as it follows, in general,

Fig. 1—Approach to Newcastle Central station from the King Edward bridge showing proximity of other property on either side of the line

the practice demonstrated to such a remarkable degree in the great relay interlocking at York brought into service in 1951. At York, however, the transition was direct from mechanical operation to panel control, and the need for change was more urgent ; Newcastle had been equipped with power signalling since 1906.

The bridging of the Tyne valley presented something of a problem to the early railway engineers, and the first line to enter Newcastle was not any part of the present trunk route from London to Edinburgh, but the cross-country line from Carlisle. The sketch map, Fig. 3, shows the layout as it existed prior to the important alterations of 1906. Until then all trains from the south entered Newcastle over Robert Stephenson's High Level Bridge, passenger and freight alike, and through trains for Scotland had to reverse direction.

In this final stage of the " one-bridge " approach from the south the layout on the north side of the Tyne was controlled by one of the largest concentrations of mechanical signalling to be found anywhere in the country at that time. There were four signalboxes having locking frames of 244, 70, 140 and 90 levers respectively, and the No. 1 box, which controlled the east end of the station and the complicated connections and crossings to the High Level Bridge, 244 levers, was the longest assembly of levers in one row then in existence. From an early date the complications of the layout would seem to have been accepted as a challenge by the operating staff and some extremely smart working was often to be seen in handling the through Anglo-Scottish trains. This reached its climax at the time of the Race to the North in 1895, when it became usual for the Tourist express from King's Cross to Aberdeen to run in from the south, over the High Level Bridge, attach its fresh engine, and be away to the north in about 2 min.

It was to relieve the congestion and " bottle-neck " character of the layout that the King Edward VII bridge was constructed, and it was in connection with the completion of this project and the enlargement of the layout to the plan shown in Fig. 2 that the complete resignalling of the entire circuit over the two bridges and along the connecting line on the south side of the Tyne was undertaken. The electro-pneumatic system was chosen, using semaphore signals, and so far as the Central station was concerned, instead of four mechanical signalboxes having a total of 546 levers, the enlarged layout was operated from three power boxes, having a total of 462 levers. The largest of these new boxes was the No. 3, at the junctions of the new lines over the King Edward Bridge and the oldest line of all, that to Carlisle. This power box had a locking frame of 211 levers, and has always ranked among the largest of its kind ever built.

It is the electro-pneumatic installation of 1906 that has now been replaced. A signal change-over always needs the most careful planning, but at Newcastle the operation was made vastly more difficult by the intensity of the train service involved. This intensity rises to its peak on summer Saturdays when a normal day's work entails the handling of 420 main line and suburban trains that are either steam or diesel hauled, 340 electric suburban trains and about eighty freights. The heaviest period is in the morning when fifty-one trains leave the station within 60 min. The replacement of the 1906 electro-pneumatic plant was up for consideration nearly twenty years ago, when the plant itself was just over thirty years old ; but the outbreak of war, and the period of financial stringency following the end of hostilities combined to delay the bringing of the scheme to fruition by more than fifteen years.

Following the successful inauguration of route-relay interlocking in the North Eastern Area of the former London and North Eastern Railway, and its application at Thirsk, Hull, Northallerton and York, the same system of control was chosen for Newcastle, with colour-light signalling throughout, and the most modern form of electro-pneumatic operation for the points. From the inception of the scheme careful consideration was given to the means of bringing it into service, and the stage work is worthy of careful study. The signals themselves were in urgent need of replacement, and a programme was worked out of renewing these as colour-light units, and operating them from the old interlocking frames. As originally installed in 1906, separate semaphore arms were used for each route, and an early stage in the modernisation consisted of changing such groups to a single semaphore, with an electric route indicator working with it, and covering all the routes previously signalled by separate arms. In these renewals the old lower-quadrant arms were replaced by standard upper quadrant semaphores, operated by the original electro-pneumatic signal motors. At a later stage the new colour-light signals were erected, and the controls from the existing interlocking frames transferred, location by location. Before the time of the final change-over of the signalling, on April 12, 1959, all the new signals were functioning, and from the enginemen's viewpoint there was no further change last week-end.

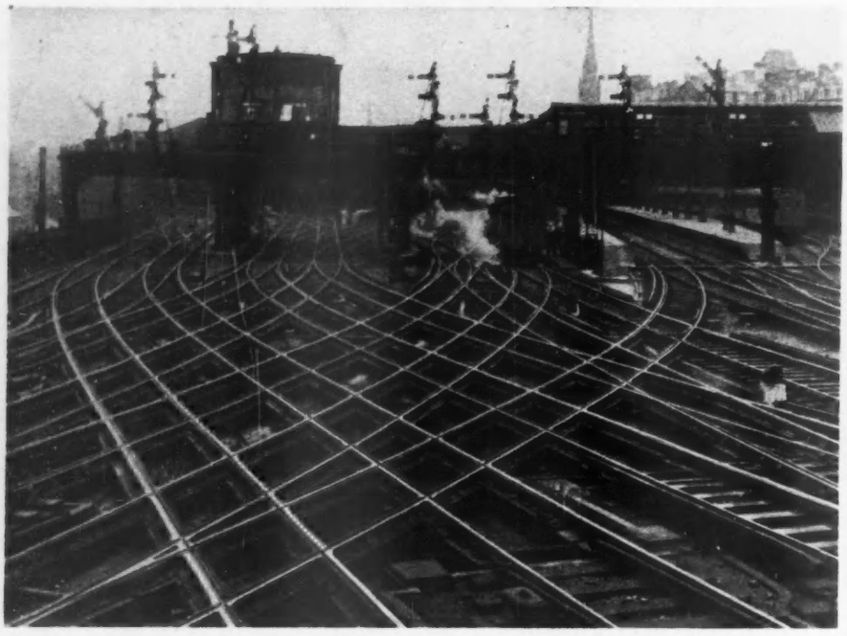


Fig. 2—Track at east end, showing signalling in an interim stage, and the old No. 1 box on gantry, still in commission

The New Signals

In the area controlled by the new interlocking plant there are ninety-four main colour-light signals, and of these sixty-one have route indicators working with them. These latter are of the "theatre sign" or multiple-lamp type, standard on British Railways for lines where the speed of running is not high. For shunting movements there are 170 subsidiary signals, eighty-four of which embody calling-on indications and work in association with the main searchlight signals. The majority can display four aspects, but those leading out of bay platforms are three-aspect. The lamp used in these signals is 12V, 12/16W, two-pin S.B.C. tripole. The 12W is the main filament and the 16W the auxiliary filament which is automatically brought into use in the event of a failure of the main filament. The second yellow aspects used with four-aspect signals are fitted with 12V, 9/6W, three-pin B.C. bipole lamps.

The "two-position light" type subsidiary signals display a white and red light in the horizontal position for "stop" and the "proceed" aspect is indicated by two white lights inclined at 45 deg. Two different lamps are used in the signals, 110V, 25W, two-pin B.C. being used for the white light, and 110V, 40W, two-pin B.C. for the red. This increase in wattage for the red lamp is to overcome the loss of illumination through the red lens. The subsidiary signals associated with the main signals are different from the ones just described, inasmuch as they have a "C" (calling-on) sign in place of a red light. Normally, no light is displayed by these signals. The "proceed" aspect is indicated by two white lights inclined at 45 deg. The "calling-on" indication is given by two white lights at 45 deg. as well as the illuminated "C" sign. These lamps are also of the 110V, 25W, two-pin B.C. type.

Because of the speed restrictions in the area controlled, the route indicators used are of the "theatre" type. They display the same indication at the front and back, the only difference being that the front indication is yellow and the back indication is lunar white. The rear indication is largely for the benefit of any staff working on the track. These indicators have forty-nine lamps, front and rear, and are capable of displaying up to nineteen different indications. The lamps used are 110V, 15W, two-pin B.C.

Point Operation

The electro-pneumatic plant installed in 1906 was among the earlier ones operating on this system. It made use of the original type of control valve in which air pressure was maintained on the piston of the point cylinder after the completion of the stroke. To maintain air tightness the piston packings were leather. Furthermore, although the area controlled from the power signalboxes of 1906 was, from the outset, fully track-circuited, protection of the points against inadvertent throwing during the approach and passage of a train was afforded by means of the old-fashioned locking bars, as in mechanical signalling. Considerable economy in lever movement was effected, however, by designing the mechanisms to operate both points and locking bar from one cylinder. In the new installation protection is afforded by track circuit locking, and the latest type of operating mechanism and valve have been used, as at York. The valve was described in The Engineer at the time of the completion of the York installation, in our issue of June 8, 1951. It may be added here, however, that this valve, known as the style C.P. (constant pressure), cuts off the air supply as soon as a full operation is complete.

While in the earlier electro-pneumatic plant at Newcastle compressed air was used for both point and semaphore signal operation, in the new plant it is used only for the points. The air main supply system is divided into two zones, one fed from a compressor station at the east end of the signalling area, and the other zone from a compressor station at the west end. Each compressor station houses a main and stand-by electrically driven compressor. Those at the east end are 20 b.h.p. units, each with a rated output of 100 cubic feet of air per minute; those at the west end are smaller, 12 b.h.p., with an output of 50 cubic feet of air per minute. In the event of loss of air pressure in any one air main, zone facilities are available whereby the air main system can be through-connected to the other zone. The power supply for the compressor motors is 440V, three-phase, 50 cycles, and an alternative supply is available in the event of an interruption of the main supply.

In addition to the three power signalboxes formerly controlling the station area, there is a fourth box—Manors—that has been dispensed with under the new installation. This latter box, equipped with a mechanical interlocking frame, was situated on the main line to the north, at the junction of the branch to Jesmond. To carry out the first stage of the change-over, in which the semaphore signals were replaced by colour-lights, and the older point mechanisms were replaced by new ones, temporary fifty-core cables were used to "tee" into the now-displaced signalboxes from the new cable termination housings until the new installation was brought fully into service.

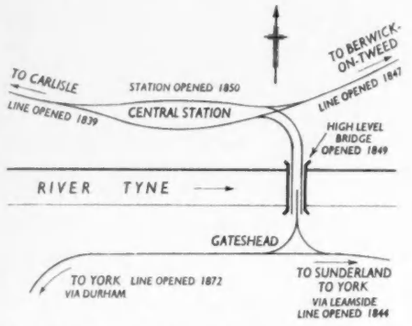


Fig. 3—Layout of Newcastle Central station from 1849 to 1906

The confined and encompassed nature of the railway as a whole in the neighbourhood of Newcastle Central station, carried on arches and viaducts, gave rise to some problems in designing and accommodating the various cable terminations housings, and in providing adequate space for the main cable run. In certain cases new stagings had to be built, outrig fashion, outside the parapet walls of the viaducts, and in another instance a substantial length of wall had to be demolished and rebuilt farther from the nearest running line. The structural design of the control and relay rooms, above and between Nos. 9 and 10 platforms, presented some interesting problems, particularly in the erection sequence; in the first stages the new framework had to be built around the existing arched station roof, which, in its final form, it supports.

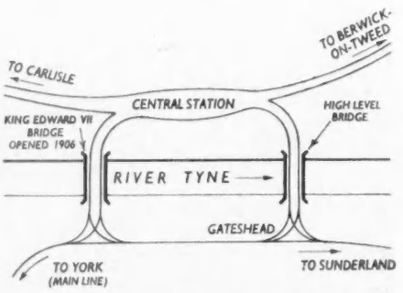
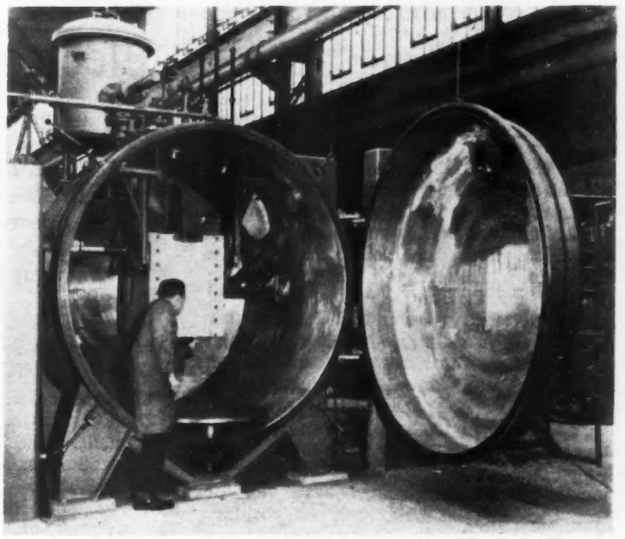


Fig. 4—Layout of Newcastle Central station as from 1906

(To be concluded)

Vacuum-Melting of Metals



Arc-melting and induction-melting furnaces now in operation at the Sheffield works of Jessop-Saville, Ltd., constitute the largest plant outside America for melting in vacuum. The furnaces are being used particularly for titanium and zirconium, but also for improving characteristics of existing steels and developing new alloys.

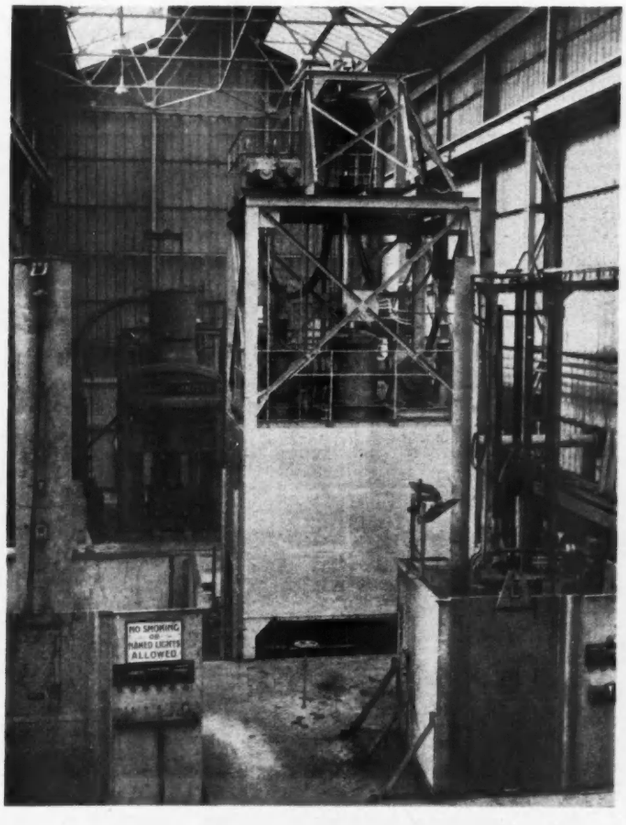
A CONSUMABLE-ELECTRODE vacuum melting furnace now in operation at the Brightside Works, Sheffield, of Jessop-Saville, Ltd., has a capacity for producing titanium ingots up to about 2½ tons in weight, believed to be the largest made on this side of the Atlantic. This development is the most recent stage in a programme dating back some eight years, when a vacuum-melting furnace was made in the company's research laboratories and used at first for melting steel, titanium being in short supply at that time. A later step was illustrated in our issue of September 27, 1957, page 448, when a 1-ton production furnace was shown, and a brief account was given of the preparation of the electrode and of the action of the process. The most recent addition to the plant is the Heraeus consumable-electrode furnace shown alongside. In this installation the furnace body is a permanent fixture and the electrode is charged from underneath. It is then welded on to the feeder rod, and the melt is controlled by applying drive to the rod, which also carries the melting current, through sliding vacuum seals, from the busbars to the electrode.

The electrode feed in either direction is controlled by two motors acting independently but coupled to the ram through a differential gearbox. One motor tends to drive the electrode in the downward direction and is energised from the arc supply, so that on short circuit it stops driving ; the other motor tends to drive the electrode in an upward direction at a predetermined rate.

Final motion of the electrode is thus the resultant of the two effects through a differential gearbox. By this means, the disadvantage of inertia associated with a reversing motor is eliminated and rapid response to correcting signals is achieved. Errors in either arc voltage or current are detected by a relay and used to operate heavy-duty thyratrons which vary the predetermined speed of the " upward " driving motor.

A further feature of the control equipment is that allowance can be made for the difference between measured and true arc voltage by automatic correction within the controller for the voltage drop across the ram, stub, weld, and electrode, provided the appropriate constants are known in advance.

A view of the melt is projected on to the melting desk by a teleoptic system. Furnace conditions are continuously recorded so that the melting operator can make any necessary modifications to control the melting to a rigid specification. The furnace components (pumps, valves, &c.) are actuated remotely from a control cabinet. There is provision for automatic operation of all vacuum equipment, so that, when the furnace is closed, evacuation is taken through all its stages entirely without supervision. This system also safeguards the vacuum equipment in cases of component failure. The arc current is interlocked to all operations which, if faulty, could lead to dangerous conditions, and a section of the cabinet is devoted to early warnings of conditions likely to lead to breakdowns so that corrective action can be taken in advance.



Consumable-electrode furnace mounted over charging pit

The vacuum equipment is capable of holding melting pressures below one micron. In this pressure range the arc is very stable. The two pumps fitted for final evacuation of the furnace have combined capacities of 4000 litres per second for air and 10,000 litres per second for hydrogen. Titanium ingots produced range from 9in diameter, 120 lb to 420 lb, through diameters of 12in, 16in, and 20in to 24in diameter, exceeding 2½ tons in weight. The plant is capable of producing zirconium ingots but it is likely that initial production will be confined to ingots up to 800 lb in weight. Steel ingots up to approximately 3 tons in weight can also be produced in the same sizes.

Current for the plant is supplied by nine Westinghouse " Wesculite " selenium rectifier banks of 2000A capacity each. Forced oil cooling is provided, with water cooling for the oil.

Over the past three or four years the company has devoted considerable study to vacuum-melting of steel, one advantage of which is that oxygen content can be reduced to well below five parts in a million. It has now installed a Wild-Barfield/N.R.C. 600 lb high-frequency induction furnace of the kind illustrated in our issue referred to above. The new furnace, now operational at Brightside Works, is shown above. This unit is designed for semi-continuous operation, provision being made to accommodate sufficient ingot moulds for several heats on the rotary mould table, and for recharging the furnace, through the bulk-charging hopper seen at the top of the illustration, without breaking the vacuum in the melting chamber.

The stainless steel horizontal vacuum

chamber is approximately 7½ft in diameter by 9ft long, and is cooled by water circulated through copper coils brazed to the outside. The refractory crucible, heated by the high-frequency melting coil, can be tilted by a motor drive for pouring into several ingot moulds or castings on the rotary table. Provision is made for observing all stages of the process through three windows, equipped with shields and wipers.

The alloy charging mechanism in the cylindrical upper chamber consists of a 2200 cubic inch bulk charging hopper, holding 300 lb of material, and four smaller hoppers, each of 90 cubic inches and holding a further 12 lb of alloys each. Both bulk charge and alloys are delivered to the crucible by a vibrating feeder through a 6in diameter vacuum lock. Alloy buckets are individually tripped by solenoids operated from the control panel. The vibrator feeds into a chute which swings over the crucible and an interlock is provided which prevents the vibrator from operating unless the chute is in position. A special pumping line evacuates this chamber after it has been recharged with material.

The pumping system is designed to handle the gases from 600 lb of molten charge during melting, purifying and alloying. Pneumatic operation is provided for all the vacuum valves used during the pumping cycle. The vacuum system consists of a large 16in diameter high-vacuum manifold and a 6in diameter rough pumping line connected to the end face of the melting chamber to allow rapid and complete evacuation of the chamber. This combined system will pump the furnace chamber from atmospheric pressure to a pressure of 1 micron Hg in fifteen minutes.

Power supply for melting is taken from a motor-alternator set comprising a B.T.H. 320 h.p. motor and a 400V, 200kW induction alternator giving an output frequency of 3000 c/s. The set is started locally by means of an Allen West auto-transformer starter, but all electrical controls required during a melt are grouped on the furnace operating platform. They include the controls for a motor-operated tap-changer which regulates the heating voltage, and for adjusting the capacity connected for power factor correction.

The furnace will be used for melting iron, nickel and cobalt based alloys. Induction vacuum melting has made possible the production of alloys which, because they contained elements which readily oxidised, could not be produced by conventional air melting methods. One such high-temperature alloy, Jessop G.64, contains high percentages of aluminium and titanium and can only be made satisfactorily in a vacuum-melting furnace. The qualities of this material are being assessed for stator and turbine blade applications.

VISIT OF FELIX CANDELA TO BRITAIN IN MAY.—The British Council, in conjunction with the Joint Committee on Structural Concrete, has arranged for the eminent architect-engineer, Felix Candela, to visit this country in May. Candela combines a professorship of design in the Faculty of Architecture at the National University of Mexico with the chairmanship of the firm of engineers and contractors, Cubiertas Ala, S.A., which specialises in the design and construction of concrete shell structures. In this latter capacity he has designed and built more than 120 shell-roofed buildings in Mexico City alone—an achievement which would seem to qualify him as probably the leading exponent of shell concrete design in the world. Candela will lecture on "Ten Years of Building Thin Shell Structures," in London and several provincial cities.

Electronic Components Exhibition

No. II—(*Concluded from page* 575 *April* 10)

Buyers and technicians from twenty-three countries visited the Radio and Electronic Components Show organised by the Radio and Electronic Component Manufacturers' Federation during the four days it was open (April 6–9). The greatest representation from abroad was from France with fifty-one buyers, followed by Holland with thirty-eight, Denmark with thirty-two, the U.S.A. with twenty-three, Germany with twenty-two and Belgium with twenty-one. A final selection of the exhibits is reviewed below.

Department of Scientific and Industrial Research

THE exhibit of the Department of Scientific and Industrial Research illustrated the work undertaken by the Radio Research Station at Slough, Bucks, in investigating the effects on radio wave propagation of the refractive index of the lower atmosphere. The refractive index is a measure of the property of the air which produces bending of radio waves. Under certain meteorological conditions the strength of an ultra-high frequency signal at a receiving station beyond the horizon is considerably influenced by the atmospheric structure and the variation of the refractive index. Earlier methods of measurement have produced only limited information on this feature of the lower atmosphere and it is hoped that airborne experiments will fill in the gaps in existing knowledge.

The first stage in this research took place at Slough about a year ago, when construction was begun of a microwave refractometer which could be installed in a "Hastings" aircraft. Equipment proving flights followed, during which the apparatus was tested under varying conditions, and the investigators are now flying with the Meteorological Research Flight of the Air Ministry, by whom the experimental facilities in "Hastings" aircraft (Fig. 7) were arranged. Studies are carried out at heights up to at least 10,000ft.

The experimental technique depends on the changes produced in the resonant frequency of a microwave cavity by changes in the refractive index of the enclosed air. A test cavity, open to the atmosphere, is located outside the fuselage of a "Hastings" aircraft at a point where turbulence created by the aircraft itself is negligible. A sealed cavity in the refractometer serves as a reference cavity having a fixed resonant frequency. As seen in Fig. 8, the frequency-modulated output from a klystron oscillator is applied to the two cavities. Voltage pulses, derived from crystal detectors connected to each cavity, are used to trigger a multivibrator circuit, which in turn produces a

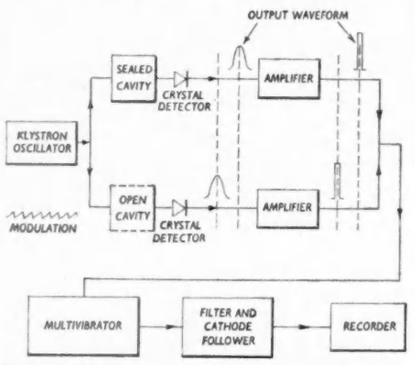


Fig. 8—Principle of airborne refractometer—D.S.I.R.

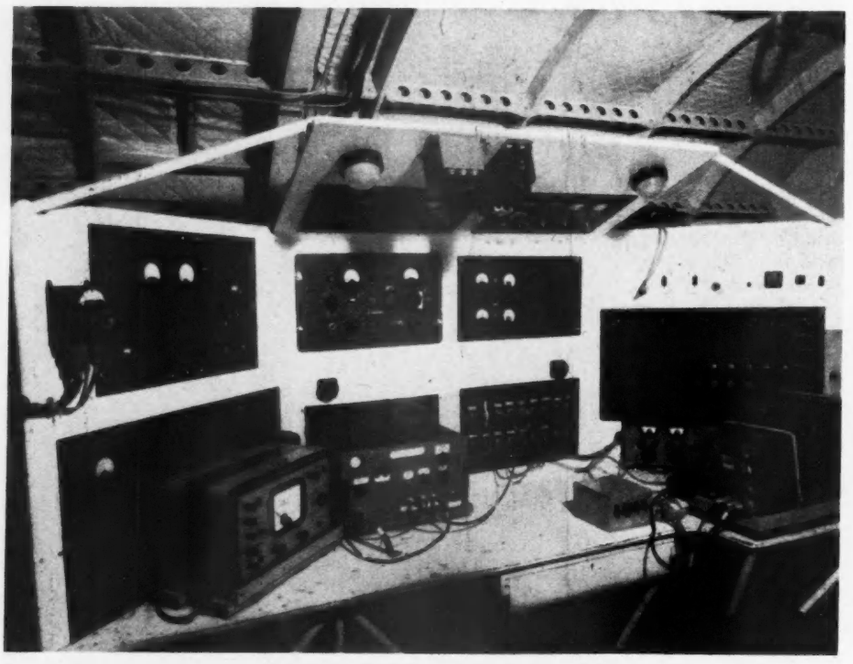


Fig. 7—Installation of instruments in "Hastings" aircraft for recording changes in the refractive index of the air—D.S.I.R.

rectangular waveform. The variation in the width of this waveform is directly proportional to the variation in the refractive index of the air passing through the test cavity. The average voltage of the rectangular waveform is applied to a photographic type recorder.

Variations can be made in the sensitivity of the instrument to record either the large fluctuations extending over a considerable height or the smaller variations which occur, for example, in or near clouds. Compared with conventional methods, this instrument can record rapid fluctuations, but a new model now being made at Slough will have an even shorter response time.

The technique described was first developed by scientific workers in the United States.

Cathodeon, Ltd.

A forthcoming reduction from 50 to 25 kc/s in the channel width for mobile radio services has placed still higher importance on accurate frequency control. The miniature crystal oven illustrated in Fig. 9 is made by Cathodeon Crystals, Ltd., Linton, Cambridge, specifically for mobile applications. The unit accommodates one Cathodeon Type 2M crystal unit (available from 800 kc/s

Fig. 9—Miniature crystal oven for mobile radar equipment. Height above chassis is 2¼in—Cathodeon

to 100 Mc/s) and can be set to maintain any temperature from +40 deg. to +85 deg. Cent. in an operating temperature range from −20 deg. to +80 deg. Cent. Within this range the bi-metallic control switch operates within ±2 deg. Cent. of the setting-up temperature. The oven consumes 4·6W and operates on a 6V or 12V supply. If fitted with a Cathodeon 1 Mc/s crystal unit, Type 2MR, the oven can be used as a secondary frequency standard.

The company has also introduced a new plug-in sub-miniature crystal unit, 2MM, matching in size transistors and other sub-miniature components. These crystals are now available in the range 5 to 75 Mc/s.

Brayhead (Ascot), Ltd.

To meet the need of reception on new television channels, a series of turret tuners adaptable to numerous home and overseas requirements was shown by Brayhead (Ascot), Ltd., Full View Works, Kennel Ride, Ascot, Berks. In addition to normal U.K. channelling, they can be provided with channels for F.C.C. or C.C.I.R. systems, or for other special channels obtaining in overseas countries. All three tuners employ a common chassis of the type shown in Fig. 10. Only the bottom portion of the three-piece cover need be removed for access to the channel biscuits. The PB–1 tuner has a ten-position rotor. Tuners PB–3 and PB–4 have been developed jointly by Plessey and Brayhead to provide, within similar dimensions to the PB–1, fourteen and eighteen channels respectively. Thus receiver chassis, tooled to accept the PB–1, can be fitted with the new PB–3 or PB–4 tuners, providing in the one case

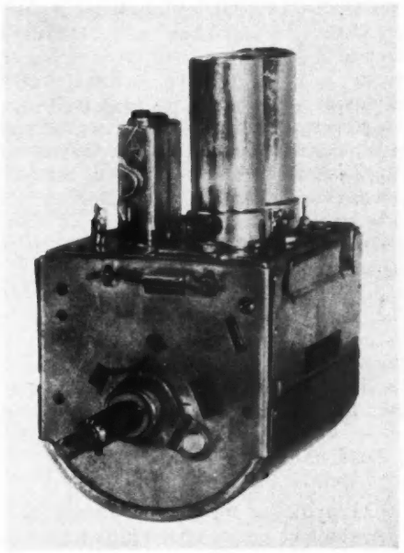


Fig. 10—Turret tuner for TV. receivers, incorporating R.F. amplifier and oscillator-mixer stages—Plessey-Brayhead

for all thirteen television channels plus an F.M. sound position, and in the other for thirteen television and four F.M. channels, with an additional position for the eventual use of a u.h.f. adaptor should this be desired.

All tuners embody a cascode amplifier with bridge neutralisation of the input circuit and a series peaking coil. Automatic gain control can be applied to the cascode stage without unduly affecting the response shape. The basic PB–3/4 tuner employs a capacity coupled input circuit specially developed to provide efficient operation on all channels. Signals are fed to this circuit via a printed i.f. filter, isolating components or balun transformer according to requirements. An inductively coupled input circuit can be supplied alternatively. Bandpass coupling to the mixer and capacitive oscillator injection are employed. Screen neutralising raises the input impedance of the mixer on the higher channels. The basic tuner employs a capacitance-coupled output circuit, although link coupling is available.

Extra contacts can be provided on channel biscuits of the PB–3 and PB–4 tuners for aerial switching, sensitivity switching, or to meet future eventualities such as u.h.f. or multi-system operation.

Ferranti, Ltd.

Two new ferrite isolators and a ferrite switch were shown by Ferranti, Ltd., Kings Cross Road, Dundee. Operation of the isolators (unidirectional attenuators) is based on the gyromagnetic resonance absorption effect. Two ferrite strips are placed along the broad waveguide walls at a position where the microwave magnetic field is circularly polarised, and a transverse d.c. magnetic field is supplied by a permanent magnet. For one direction of propagation, the microwave magnetic field is circularly polarised in the same sense as the electron spin precession in the d.c. field, and for the other direction is in the opposite sense. The result is that at the gyromagnetic resonance frequency there is a large absorption of power in one direction and very little in the other. The non-reciprocal effect is enhanced by dielectric loading of the waveguide.

The Ferranti 2FX-band ferrite isolator is designed for operation up to an incident peak power level of 100kW (or 200kW in a pressurised line) and a mean power level of 250W. The isolators can be tuned to frequencies between 8250 and 10,000 Mc/s, covering a band width of ±5 per cent about the centre frequency. For the S-band a high-power water-cooled isolator (2F/10) has been introduced. Peak incident power level for this unit is 2·5MW (in a W/G10 line pressurised to 2 atm.) and mean power level 2·5kW into a load mismatch of better than 2 : 1. Frequency bandwidth is ±5 per cent with centre frequency 2500–3000 Mc/s. A cooling water flow of 1000 cubic centimetres per minute is required.

The ferrite switch, 3F/1, also makes use of the Faraday rotation effect exhibited by ferrite materials in the presence of a magnetic field. It is designed to operate in the frequency band 9100 to 9900 Mc/s and provides a maximum attenuation of 30 dB.

An axial magnetic field is produced in the ferrite-loaded circular waveguide section by current flowing through a concentric solenoid. In operation, two sections of waveguide 16 are bolted against the flanges of the switch, the two sections being in the same plane. A TE_{10} mode in the input rectangular guide launches a TE_{11} mode in the circular waveguide of the switch, with the electric vector parallel to the narrow walls of the rectangular waveguide. When the magnetic field is of such a magnitude that 90 deg. rotation of the plane of polarisation is produced, the microwave field cannot be propagated in the output guide, which then looks like a short circuit to the incident field. The field is therefore reflected, undergoing a further 90 deg. rotation in the same direction, and arrives in the same plane as the incident wave at the input face of the switch so that it can be propagated back along the input guide.

To increase switching speed, the solenoid is wound in two sections, thus reducing capacitance, while the switch body is slotted to minimise eddy current losses. The slot is bridged by a thin metallic film with dielectric backing in order to eliminate radiation.

By applying a current pulse of suitable magnitude to the solenoid, the switch acts as a pulsed reflective attenuator, applicable to aerial switching. The device can act similarly as a controlled calibrated attenuator, providing a method of a.g.c., and as an amplitude modulator if a suitable periodic current waveform is applied to the solenoid. This latter application permits detection of microwave signals at audio frequencies without the frequency-modulation introduced by modulation of a klystron control grid or reflector.

Materials Handling Conference.—The first international conference of the Institute of Materials Handling is to be held in London at the Waldorf Hotel from Wednesday, May 6, till Friday, May 8, next. The conference will be opened by Sir Edward Beddington-Behrens and amongst the subjects discussed will be "The Role of Containers and Pallets in International Transport," "Material Handling and Ships," "Material Handling in the Manufacturing Industries," and "Handling in Warehouses." Speakers from a number of countries will take part in the discussions and visits to several industrial establishments have been arranged to amplify the work done at the meetings.

LETTERS AND LITERATURE

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

FAIRLIE LOCOMOTIVES

SIR,—I have just been reading, rather late, Mr. R. A. S. Abbott's article in THE ENGINEER for December 5, 1958. In 1941, to the best of my knowledge and belief, the Eritrea Railways were operated by Fairlie type locomotives. Whether these locomotives are still working I would hesitate to say. As far as I know, the Eritrea Railways, although an Italian State concern, were originally built and equipped by an English company.

N. CHARLTON

Middlesbrough,
Yorkshire,
April 7, 1959.

LAUNCHING BALLISTIC MISSILES FROM SHIPS

SIR,—Since I wrote to you at the end of 1957 I have noted a succession of leading articles devoted to the weapons of the nation's defence, but I do not recall that in any one of them there can be found evidence to support the bald assertion you made on April 10 : " Britain neither needs, nor can she afford, to build ships whose sole purpose is to launch ballistic rockets." I submit, Sir, that all that has become known in the intervening fifteen months has reinforced my contention that a mobile launching platform would be less, not more, costly than fixed emplacements, when, as must be the case in Great Britain, their location is known to the intended target. It cannot have escaped your attention that, because of the monstrously slow reaction time of the " Blue Streak," it will be necessary to provide it with " hard " launching sites—imagine the cost of an elevator to lift 50-ton objects 140ft, embedded in a monolithic cast of concrete—and that, since the launching sites can easily be kept under radar surveillance, it is now proposed to include e.c.m. in the precious payload. In contrast, seaborne carriers would need no protection from surprise attack : on the contrary, intense efforts to find and fix them would, perhaps, be a pointed warning of impending danger. Further, since they might be beached anywhere from the Persian Gulf to the North Cape, the interception of their missiles, even if discharged " gunfire," is not going to be cheap, even if it is possible. One difficulty has made itself apparent to me during the long interval in which I have been hoping to see some sign of enlightenment at decision-making levels : the launch crew would have only about four hours to find a really accurate azimuth reference—I would hope that star tracking, which, with modern equipment, is possible in daylight, would meet this requirement, but I admit I have not asked the instrument makers to tender for adequate equipment.

Another highly relevant consideration in this context, I submit, is the now indisputable existence of political difficulties in establishing launching bases when to do so is merely to create a target for the i.r.b.m. already deployed. If only two countries in Europe are prepared to accept United States missiles, it is more than doubtful whether any possibility exists of deploying " Blue Streak " outside the confines of this island. Since it is now irretrievably cast as a few-off, high-cost weapon, it appears to me to compare more unfavourably than ever with the many L.S.T.-like vessels that could be procured at the same cost to deploy the less costly " Thor " or " Jupiter." And cancellation of this weapons system might make available a handful of useful boosters for research in, or even beyond, the upper atmosphere !

" HINCHCLIFFE "

London,
April 13, 1959.

[Our apologies are due to " Hinchcliffe." The words he quotes appeared in a leading article confined to a discussion of submarines; we should have made it clear that it was only to that class of ship we were referring. We feel the less repentant in that " Hinchcliffe " has thus been offered (and has taken) the opportunity to stress again the advantages of launching ballistic missiles from surface ships. —ED., THE E.]

Book Reviews

Ensembles Mesurables Et Probabilisables. By PROFESSOR D. DUGUE. Dunod, Editeur, 92, rue Bonaparte, Paris(6e). Price Fr. 850

THIS book is the first of a collection under the title : " Probabilités, Statistique, Recherche Operationnelle," under the general direction of Monsieur Georges Darmois, Membre de l'Institut, Directeur de l'Institut de Statistique de l'Université de Paris, who defines the main object as follows : " To bring the contributions of mathematics to bear on problems in the real world."

In regard to the work under review, Monsieur Darmois stresses the following point : " Although it may appear a little remote from the concrete, it is intended to show the immense and fundamental role played in the theory of measure by Emile Borel and Henri Lebesgue, two great mathematicians who always kept in close contact with reality."

The subject leads us to reflect on this notion of the measure of sets, which is absolutely fundamental in the calculus of probabilities, since without such a notion it is impossible to give a definition of probability which does not, when applied to real problems, lead to a number of inconsistencies and paradoxes. We recall the weaknesses of the definition : the number of favourable cases divided by the number of possible cases. The book, which reconstructs the line of thought of Emile Borel and Henri Lebesgue, is in five chapters.

The first chapter summarises a certain number of definitions and fundamental notions on linear point sets, and introduces the symbolism used in operations on sets. Linear sets are expounded as well as the notion of a limit point which leads, with the Bolzano-Weierstrass theorem on bounded infinite sets, to the notion of derived set ; and the notion of denumeration and of one-one correspondence which leads to that of the power of a set. The chapter also gives the important Borel-Lebesgue theorem on the covering of a bounded closed set E by a finite number of intervals when every point of E is interior to an interval belonging to an infinite family.

The second chapter is devoted to the measure of sets. Three definitions of measure are given in succession :

(1) In the sense of Riemann (R measure), linked with the existence of the Riemann integral of the characteristic function of the set.

(2) In the sense of Borel, linked with a process of generation of sets starting with open intervals.

(3) In the sense of Lebesgue, based on the notion of an open set, which also presupposes the definition of interior and exterior measure along with a zero measure of a set contained in a segment.

This last definition, which is the most general, makes it possible to establish a certain number of theorems on the algebra of sets (sum, intersection and limit of measurable sets).

Chapter three revolves round the Lebesgue integral and the properties of functions which are integrable in the sense of Lebesgue integrable L. The Lebesgue integral is defined and related to an integral of Riemann—Stieltjes sort. Its properties are compared to those of the Riemann integral. In order to show that every function integrable R is also integrable L, a certain number of theorems on the limit function of a sequence of functions, defined on a Lebesgue measurable set or themselves measurable L, are proved (in particular, Egoroff's theorem). Finally, it is proved that the functions obtained from measurable functions by the operations of addition or multiplication are themselves measurable.

On the other hand, Zermelo's axiom of choice makes it possible to define on the circle of sets which are not measurable L. To conclude, the notion of a point of condensation and the properties of sets which stem from it leads to a proof of the Cantor-Bendixson theorem on the structure of a closed set.

Chapter four approaches the real world, since, with the help of concepts already established, it tackles " probabilisable " sets. Length has hitherto been taken as the most natural form of measure, being the important role played by open intervals, but it must be admitted that this choice was not necessary for one can substitute for it a function F, which by analogy with length must be monotonic, non-decreasing, bounded and defined everywhere. Under certain conditions of continuity, it then becomes possible to define " probabilisable " sets according to F (a distribution function).

F is decomposed into three parts, a jump function, an absolutely continuous function,

and a function, varying on a set of measure zero. Cantor's ternary set makes it possible to illustrate this last kind. On the other hand, the same Cantor set makes it possible to show that there exist sets measurably L but not probabilisable.

The Lebesgue-Stieltjes integral, which is met so often in the calculus of probabilities, is introduced under its most general form, starting from functions measurable B. A theorem due to Reisz and Lebesgue shows the scope of this functional. Finally, the support of a measure is defined by the distribution function and from this is deduced the properties of the addition of two random variables in the form of a vector sum of supports.

The last chapter deals with the rarefaction of sets of measure zero and with the work done by Emile Borel in this field. Two processes of construction of sets of measure zero are given :

(*a*) By the series of intervals of contiguous inclusion and

(*b*) By the series of intervals of inclusion overlapping the one on the others.

The rapidity of convergence of the series gives the rarefaction

$$\left(\text{example of numbers approachable within } \frac{1}{q_n^{2+a}}\right).$$

There follow two special theorems relating to the vector sum of the sets of measure zero generated by the exclusion of middle intervals, which introduce two notions due to Emile Borel generalising the scope of the results following from these theorems. These two notions are logarithmic rarefaction and relative minimum rarefaction which expresses in some manner the relative gap left by the exclusion of the middle interval.

Advances in Inspection Techniques as Aids to Process Control in Non-Ferrous Metals Production. Monograph and Report Series No. 24. Institute of Metals, 17, Belgrave Square, London, S.W.1. Price 30s.

THIS book is likely to prove fascinating to many practical engineers and metallurgists, and the Institute of Metals is to be congratulated on making it available. It covers much that is fundamental to mass production and high-pressure engineering. On the occasion of its annual meeting in May, 1958, the Institute of Metals held a symposium in London at which a general discussion followed the presentation of eight papers. These papers have now been gathered together in this 102-page quarto monograph which thus records the proceedings. They commenced by considering automatic gauge control in rolling mills. After briefly presenting the theoretical background to the problems of automatic gauge control (A.G.C.), which has been developing in rolling mills during the past twenty-five years, an account was given of installations which have been made of the Davy-United/B.I.S.R.A. system on reversing and tandem mills. Dr. R. B. Sims concluded that when fully developed for hot mills, A.G.C. would bring very considerable benefits in gauge savings on hot rolled products and in easing the rolling problems at the cold mills. In his paper on " The Accuracy of Strip-Thickness Measurement by Beta and Gamma Absorption," E. B. Bell considered fundamental and operational accuracy limitations. In particular he referred to statistical variations, detector sensitivity variations, electronic drift, movement of absorber, and variations of these errors over the range of the instruments.

Carlisle and Wilson's paper reviewed non-destructive measuring techniques developed for use on continuous steel strip processing lines. Coating thickness is measured by X-ray fluorescence while strip width and thickness is controlled and pinholes and laminations detected in the steel. In the steel strip finishing and tinplate industry instrumentation and automatic control must be closely integrated with research into process technology because developments in the technology of the process may radically affect, and may even eliminate, the need for automatic quality control of a product.

Turning now to light alloys, Harris and Crowther recorded that the increasing use of ultrasonic testing in final inspection, and at earlier stages in processing, has led to a marked improvement in the quality of high-strength aluminium plate, extrusions and forgings. Some experience with copper alloys is also reported. Sooner or later as such novel techniques become widespread, the need for standards arises, so it should be noted that the D.T.D. Specification is expected to cover the inspection of extruded and forged aluminium alloy bar with appropriate provisions. A paper on " Instrumentation in Ultrasonic Flaw Detection," by D. G. W. Claydon, then followed, giving the aspects of the problem most widely appreciated among engineers. Then came N. B. Harvey's paper on the use of a search-coil apparatus for eddy-current testing of copper and its alloys. The main uses of the instrument in the quality control of copper and its alloys are for the direct measurement of electrical conductivity, the quantitative determination of small additions of a second element to copper, and the indirect measurement of tensile properties in age-hardening copper alloys. Sorting of scrap and flaw detection are other employments for this instrument.

Next in " The Inspection of Tubes for Flaws and Variations in Thickness," Robinson and Perriam described the practical application of eddy-current inspection techniques for inspecting condenser tubes after a period of service as well as for detecting flaws in tubes during manufacture. R. Halmshaw described methods which have been advocated for reducing the cost of radiography and of increasing its speed, namely, fluoroscopy, electronic image intensifiers, miniature film recording techniques, use of X-ray paper, Xeroradiography, ionography and scanning with counters.

Reverting to the light alloys, Ransley, Talbot and Barlow described an instrument for measuring the hydrogen gas content of aluminium alloys during melting and casting. The instrument finally evolved depends on the circulation of a small stream of nitrogen through the metal and difficulties were encountered in the construction of the probe inserted into the molten metal. Still another aspect of the problem was described by Milbourn and Gidley in detailing the use, as aids to process control, of self-recording spectrometers. The rapid availability which they permit of accurate analytical results on aluminium alloys has allowed full compositional control of the casting process to be established. Control of copper alloys, while not yet so complete, has been effected in respect of several constituents.

The book concludes with sixteen pages which record a morning and afternoon general discussion which engineers may well find to be illuminating. With electrolytic tinplating speeds going up to 2000ft per minute and delivery speeds on tandem mills rolling tinplate base or light gauge steel strip commonly 5000ft per minute, inspection will certainly need all the aid possible from modern techniques such as those here described.

Books Received

The Aeroplane Directory 1959. Temple Press, Ltd., Bowling Green Lane, London, E.C.1. Price 30s.

The Great Tide. By H. Grieve. County Council of Essex, County Hall, Chelmsford, Essex. Price 30s.

Wärmeaustauscher. Vol. IV. By R. Gregorig. H. R. Sauerländer and Co., Aarau, Switzerland. Price Fr.45.

S.W.F. Handbuch. Franzis-Verlag, München 2, Luisenstr. 17, Eingang Karlstr., Germany. Price DM.19.50.

The Nimonic Alloys. By W. Betteridge. Edward Arnold (Publishers), Ltd., 41, Maddox Street, London, W.1. Price 80s.

Work Measurement. By V. H. Rotroff. Chapman and Hall, Ltd., 37, Essex Street, Strand, London, W.C.2. Price 39s.

Analyse de Variance et Plans D'Experience. By D. Dugué and M. Girault. Dunod Editeur, 92, Rue Bonaparte, Paris (6e), France. Price Fr.800

Analysis of Pipe Structures for Flexibility. By J. Gascoyne. Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, London, W.C.2. Price 45s.

Engineering Science. Vol. II. Second edition. By H. B. Brown and A. J. Bryant. Macmillan and Co., Ltd., St. Martin's Street, London, W.C.2. Price 15s.

BEAMA Annual Directory and Buyers' Guide. Twentieth edition. The Bristol and West of England Engineering Manufacturers' Association, Ltd., Royal London House, Queen Charlotte Street, Bristol, 1.

Obituary

J. H. O. BUNGE

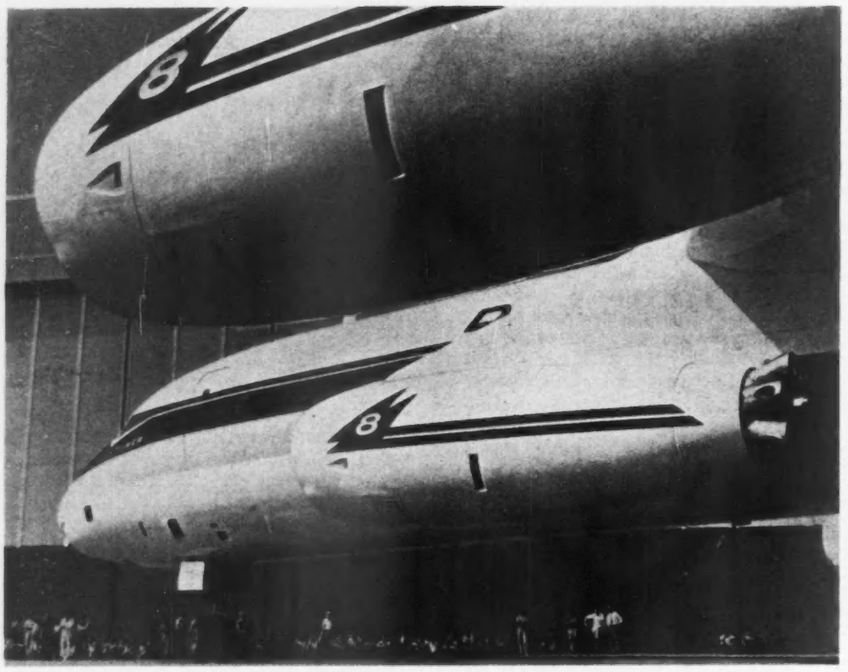
THE death occurred on April 9, at the age of 82, of Mr. Julius Hendrik Otto Bunge. He will be remembered principally as an enthusiastic exponent of the Thames barrage project, and he was in fact the secretary of the Thames Barrage Association, a body which was particularly active before the war, and which ceased to exist only quite recently.

Julius Bunge was born in Holland. His early career in mechanical engineering, when he was concerned with steam turbines, pumps and waterworks plant, was spent in the U.S.A. Later, however, he held managerial positions with various firms in the glass industry in Holland and then from 1918, in this country ; he was especially interested in glass machinery. He became a member of the Institution of Mechanical Engineers in 1927.

In the early 1930s Bunge became organising secretary of the Thames Water Bus Company, and then secretary of the Thames Barrage Association. Support for the proposed barrage became so strong that a public inquiry was arranged, just before the war. It was never held, however, because the Committee of Imperial Defence opposed the scheme because of its vulnerability to bombing. However, Bunge's book " Tideless Thames in Future London " was published in 1944. He set out all the arguments for the barrage, and answered his critics quite fully in this book. In many ways it is a pity that Bunge or his Association are not active to-day, for the barrage is once again a live subject, following the Waverley Committee's recommendation that a barrier should be provided across the river to stop the penetration of storm surges. That is only one new factor however, since a great deal of research on pollution and the hydraulic behaviour of the river has now been done, and a large-scale hydraulic model of the tidal Thames has been built. Thus many of the pre-war controversies could now be resolved scientifically. It may well be that Bunge's ideas will still find enthusiastic advocates in the future, and that, like many innovators, he proposed them twenty or thirty years too soon.

Aircraft Engineering in the United States of America

On Wednesday last week, Mr. Donald W. Douglas, Jnr., president of the Douglas Aircraft Company founded by his father, gave to the Graduates and Students Section of the Royal Aeronautical Society a lecture entitled "The American Aircraft Industry," and subsequently answered questions from the members. We reproduce part of the proceedings and a picture of a recent Douglas product, D.C.-8 airliner.



FROM January, 1954, to January, 1957, the aircraft and parts industry increased its employment of scientists and engineers assigned to research and development projects by 105 per cent. In the same period, the industry and its suppliers increased scientific and engineering personnel by 75 per cent, while all industries increased such talent by only 30 per cent.

Equally dramatic are the innovations in manufacturing methods. We are using tools undreamed of a few years ago and working with materials on a regular basis which were then only laboratory samples. We are designing tools to handle whole new families of materials, at the same time that we are developing the materials themselves.

An interesting example is beryllium. At Air Material Command Headquarters near Dayton, Ohio, nearly half of the world's supply of sheet beryllium suitable for aircraft use is stored.

Beryllium is six times stronger than steel, on a strength-to-weight ratio, weighs about one-third as much as aluminium and will maintain its properties at 1200 deg. Fah.

An intercontinental missile constructed of beryllium could be fired into outer space, far above its presently designed altitude, using to-day's power plants. The exceptional stiffness of beryllium would simplify the complicated I.C.B.M. guidance system, since the missile would be completely rigid in flight without the flexing and rippling allowed by the softer materials used to-day. The guidance system would not, therefore, have to correct and recorrect for each small change in direction.

A Mach 2·5 fighter made of beryllium would weigh 16,000 lb less than the same fighter fabricated from steel. Translated into operating capabilities, this means the beryllium aircraft would have an 8 per cent superiority in altitude and a range increase of 16 per cent, aside from its great heat-resistant properties.

Now, why don't we use beryllium in aircraft and missiles to-day ?

First, this "stockpile" of sheet beryllium at Dayton is kept in a filing cabinet. Aside from the supply problem, there are other serious disadvantages. It is highly toxic ; machining operations would require a really effective evacuation system to protect workers. Beryllium is as difficult to machine as glass would be, and abrades all known cutting tool materials. Bending a piece of beryllium is as difficult as bending a sheet of plate glass.

Cost is another serious problem. Beryllium would cost about 200 dollars a pound or more installed on an aircraft or missile frame. This is more than £4 an ounce.

Bringing beryllium out of the laboratories and on to the production lines is just one of the hundreds of problems faced by the industry to-day.

For instance, the problems of machining are immense. Only 12 per cent of the total manufacturing effort of a World War II fighter aircraft consisted of machining operations. This requirement has increased to an estimated 30 per cent for some of to-day's combat planes. There apparently exists an almost linear relationship between machining hours per aircraft pound and the Mach number of the vehicle. A very high performance aircraft could require as much as three machining hours for each airframe pound, or even more. This amount of machining is obviously prohibitive.

New methods of machining are proving of great value in solving manufacturing problems. Chipless processes, including chemical milling, electro-grinding and electro-spark, electrolytic and ultrasonic techniques are among the most successful : all of these utilise one or more mechanical, chemical or electrical phenomena to remove metal.

The U.S. Air Force is supporting a project to determine the feasibility of ultra-high-speed machining of the new hard materials at from 30,000 to 50,000 surface feet per minute. One test of this theory of high-speed machining is interesting. A tool bit was fired from a rifle at a workpiece to study the cut and plastic deformation. It is unlikely that we will be machining metal by firing it from a cannon, but then I wouldn't bet against it.

Actually, the use of explosives as a machining technique is being developed now. Basically, the explosive method releases energy from a powder charge at such a high rate that the metal is punched or formed before it knows what happened : it is used to work materials so tough or brittle that they cannot be handled any other way.

Another major manufacturing improvement is the numerical control of machine tools. One major aircraft manufacturer has described this as the most radical in the life span of his company.

Studies indicate that numerically controlled tools will show a performance from three to ten times as great as conventional production methods. There are other benefits, such as less set-up time, greater accuracy of dimensions, elimination of human error and less material scrap. Numerical control is being widely adopted throughout the aircraft industry to produce a better part more economically.

Even the oldest form of the metal working art—casting—has been improved. We are experimenting with pure ceramic materials which are fired and glazed under very high temperatures to produce a mould of great accuracy and a finish as smooth as the best chinaware.

The casting process offers the best chance to produce a part that will closely approximate the finished part. This cuts down the amount of machining required and permits the use of more general-purpose machines, rather than the huge, specialised machines required to finish crude castings. For example, a landing gear door made from a one-piece casting replaced fifty-five stampings held together by more than 1600 rivets. In another case, a landing gear fork was made from a single casting which was 5 per cent stronger and 25 per cent lighter than the three forgings formerly required.

Jewel bearings, which are a vital part of our advanced guidance and control systems, provide an example of our efforts to improve manufacturing methods. During World War II, Switzerland was our only source of supply for jewel bearings. Getting the bearings out of Switzerland was a cloak-and-dagger exercise that rivalled the Hollywood versions of undercover warfare. Now we have mechanised the production of synthetic jewel bearings to a point where we are able to produce 55,000 blanks in an eight-hour day

with one machine, compared to a former rate of production of 300 to 400 a day by one person.

We are exploring thousands of avenues in our search for new materials, as well as new manufacturing methods—and materials and methods are interdependent.

This is illustrated by sandwich materials—thin-gauge sheet metal exteriors with honeycomb or corrugated cores—which have solved the problem of a structural material with a favourable strength-to-weight ratio. Sandwich materials are being extensively used and we are trying to develop automatic fabrication machinery to lower the cost.

Some of the new exotic materials we are concerned with to-day are zirconium, niobium, palladium, lanthanum, and columbium. We also are at work with radioactive isotopes to study the changes that occur in basic metals when they are subjected to nuclear radiation. Tungsten may be changed to some yet-unnamed material that will have greatly enhanced properties. We have to-day ninety-eight elements and more than 300 isotopes for creating new materials.

New processes and new materials have required the construction of specialised research and development facilities. These have been and are being constructed for almost every phase of weapons systems development, testing and manufacturing. For example, we have had to build facilities to test rocket power plants with thrusts of 1,000,000 lb and other facilities to conduct research on ion propulsion units which develop only $^{1}/_{4200}$ lb of thrust : this apparently insignificant force has tremendous significance in frictionless space.

Here is what the design engineers considered in constructing some of our new facilities.

First, new foundations for the assembly rooms had to be built within the main factory to still vibration effects from other plant operations and from street traffic.

Plumbing and wiring had to be arranged so that maintenance could be handled from spaces between the " clean " rooms.

Overhead lighting had to be designed flush to the ceiling. Since maintenance workers cannot be permitted in the clean rooms, there had to be provided a crawl space in the roof for bulb replacement.

Elimination of dust particles in the rooms called for an atmospheric control system which utilises charcoal filters. This system ensures that 99·8 per cent of airborne particles larger than twelve-millionths of an inch are excluded from air entering the rooms.

Temperature in the rooms had to be constant ; not more than 2 deg. variations could be allowed, and in one case this was reduced to 1 deg. In this critical room, normally occupied by four men, the accidental entry of more than one additional worker could cause a disruption of the rigid temperature control system because of body heat, and production would have to be halted temporarily.

To forestall dust collection, the interiors of these rooms could have no corners ; they had to be rounded off. Walls and ceilings were covered with a special vinyl sheeting that must be washed every other day. The work benches, built of stainless steel, were extended from the walls in a cantilever design to eliminate leg supports, another possible source of dust collection. The floors must be cleaned daily by a special wet vacuuming process using liquid freon.

Clean room design called for construction of air locks, through which parts to be assembled are passed. These parts must be cleaned prior to their entry into the assembly room ; they must also be polished and examined under 45-power microscopes to permit detection of infinitesimal metal burrs. Dental drills are used to eliminate such burrs.

Once inside the assembly room, the parts are cleaned again by ultrasonic vibrations in water and detergent solutions. After the final cleaning, the parts are not touched again by human hands ; they are handled mechanically by tweezers and medical-type tongs. These tools are subjected daily to the same cleaning process.

Along with these precautions, equal care is taken to ensure that working personnel entering the assembly rooms do not introduce dust. Entry is made in two stages. The worker must first doff street clothing and scrub his face and hands. He then enters a final dressing room where he puts on a " flying suit," a hair covering and shoe boots, all made of lint-free nylon. Next, he passes through an " air shower," which removes loose particles of matter.

Such employees are carefully screened. A worker with dandruff, for instance, would be eliminated.

Conventional blueprints and paper pads for noting data are not allowed in the clean rooms, because the paper might shred. Paper has been replaced by special plastic sheets. At the same time, the pencil has been eliminated in favour of the ball-point pen, because tiny pieces of graphite might find their way into a gyro assembly.

In the earlier stages of manufacture of a missile component, where there is less need for these extreme precautions for cleanliness, there are other problems. For instance, the precision and tolerances of each part are such that, by comparison, a watch factory would look like a locomotive repair shop. Measurements in tenths of thousandths of an inch are crude and completely unacceptable for some parts. The scale is in fractional millionths of an inch.

Discussion

We give in condensed form a number of the questions and the corresponding answers.

Were the fiscal policies of the most important customer, the United States government, suited to the purchase of the products of the aircraft industry ? Mr. Douglas knew of no manufacturer satisfied with these policies : they are adverse to the industry. Renegotiation was an example of a harmful practice : manufacturers were expected to depreciate a building over thirty-three years, which was unrealistic. The industry would need to increase progressively the amount of research and development done, and hence it was vital to make profits on current work.

Would a supersonic airliner be forthcoming without government financing ? Douglas have *always* produced commercial aircraft with their own money. Considerations of attainable lift/drag ratios rendered M.3 the minimum supersonic cruise for long-range aircraft, and it appeared to Mr. Douglas that civil aircraft of this performance were ruled out by the limitations in manufacturing techniques discussed in the lecture. Tyres for landing wheels, seals and hydraulic fluid for such aircraft all appeared impracticable. The company had spent 200 million dollars on the D.C.-8, but a supersonic airliner would cost it 2000 million dollars; just as the D.C.-4 had progressed through the D.C.-6 to the D.C.-7, so he expected the D.C.-8 to develop with the needs of the airlines. In addition, it might well be that ballistic vehicles of roughly M.15 performance would prove easier than the high-speed aeroplane.

Since the airlines might not have paid off their purchases of the immediate future until 1970, was there any prospect of another generation of subsonic transports appearing ? There were probably enough large jet aircraft already in existence, but new small jet designs might appear.

What prospects were there for the helicopter industry ? Contemplation of lifting rotors left him convinced that there was no remedy for the high operating costs of helicopters. Douglas had studied many v.t.o.l. and s.t.o.l. projects, because the problem of distributing passengers away from major airports was becoming more acute.

Would the introduction of highly productive new aircraft cause an insoluble problem in disposing of existing equipment second-hand ? Douglas had built 1046 D.C.-6 and D.C.-7 transports, and he did not think there would cease to be a second-hand market for them—certainly he could sell them himself if only he could pay his workers in kind with the products of undeveloped countries ! This was not a new problem to the company : after World War II thousands of Douglas transports were in use that had yielded no profit to, but created a major spares problem for, the manufacturer. The new and more productive aircraft would probably increase the volume of travel and therefore the amount of distribution flying over local service lines, and the superior passenger amenities of the jet airliners would render passengers intolerant of unpressurised machines such as were still in service. The only problem was to organise the selling of second-hand aircraft, like that of new ones, by organisations such as the World Bank.

Was there a future for nuclear power in civil aircraft ? The nuclear powered aircraft, like a sailing ship with its own tail wind, was exceedingly attractive. Mr. Douglas believed that in aviation, as in all other forms of transport, cargo would come to form the largest portion of the business, and for cargo flying nuclear power might well be practical. Nuclear power would allow a break-through in the logistics of war, since it would allow air transport to be used when there was no possibility of refuelling for the return journey.

B.C.U.R.A. Open Days.—The British Coal Utilisation Research Association states that it celebrates the twenty-first anniversary of its foundation on April 22 and that to mark the occasion its laboratories will be open to inspection from April 22 to 24 inclusive, April 22 being private members' day, when Lord Mills will open the proceedings.

Liquid Fuels Conference.—The Institute of Fuel is holding a Second Liquid Fuels Conference, the subject being " Major Developments in Liquid Fuel Firing, 1948–59." The object of the conference is to bring up to date information presented at the 1948 Conference and it will be held in Torquay from Monday, May 11 to Thursday, May 14. Twenty-one papers are to be presented : enrolment forms are available from the Secretary of the Institute, 18, Devonshire Street, London, W.1.

Silicone Lubricants.—A range of silicone lubricants now being marketed by Shell-Mex and B.P. Ltd., have a high resistance both to thermal decomposition and to oxidation, and very high viscosity indices. These oils and greases are particularly suitable for applications where temperatures of over 150 deg. Cent. are involved, in which cases the effective life of lubricants based on petroleum is restricted. The silicone oils in the range contain an additive which confers anti-corrosion properties, and are made in three grades—light-medium, medium-heavy and graphited. One of the greases also contains a proportion of molybdenum disulphide to permit its use at higher temperatures and for heavier duties than the standard silicone grease, which is for use at temperatures up to 200 deg. Cent.

Organising Scientific Research

At the annual meeting of the Institute of Metals, which has been held in London this week, Mr. G. L. Bailey took office as president. His presidential address, which was delivered on Tuesday morning, included an informative survey of the organisation of research in various countries. Extracts from the address are given here.*

IT is universal throughout the world that the main effort in pure research is in the universities. Government and industrial laboratories frequently set some effort aside for purely scientific studies with no immediate application in view, but the sum total of their efforts in this direction is probably less than that in the universities. Applied research is the first objective of the industrial research laboratory which is mainly set up to improve the products and the processes of a company and create new ones. Government laboratories, especially those engaged on defence work, necessarily devote most of their effort to applied research. There are, however, other facilities for applied research which vary in different countries ; some is done in educational establishments, some in co-operative research laboratories, and some in institutes for sponsored research. Nowhere can a hard and fast line be drawn as to what is and what is not suitable research for a particular kind of laboratory. Some highly important results have accrued from the substantial effort devoted by some large industrial laboratories to the purest of pure research. Universities, on the other hand, have made valuable contributions to technology, but I am not in general in favour of the undertaking of applied research in universities. University post-graduate work is mainly a training—a training in both manipulation and in a habit of thought—and the student should not be closely tied to the restricted course essential in solving an industrial problem. More important than this is the necessity to maintain sufficient effort on fundamental work, and complete freedom in university research is a major contribution to this end. The higher educational institutions should give the greatest attention to quality and to making the best use of the exceptional individual.

The institute for sponsored research is generally confined to applied research, since its object is to give service to a particular client, but in some cases work of a basic kind is carried out, financed by profits or, in the case of the Mellon Institute, by endowment. My main object is to try and discover how the research effort of different countries is utilised for these various purposes, what the total effort is, who provides the money and where and how it is spent. Unfortunately, statistics are too meagre to permit me to do this properly. Figures for the United Kingdom and for the United States of America are fairly good, but only when related to 1955–56 ; in other countries the gaps get wider and wider.

A country's research effort can be measured in various ways and in what follows I have tried two methods of assessment : (1) the proportion of a country's scientific manpower devoted to research, and (2) the ratio of a country's research expenditure to the value of either its gross national product or the net output of industry, which I take to be roughly the sales less raw materials cost. Where G.N.P. is used it must be remembered that this figure includes minerals and agricultural products as well as " invisible exports " like shipping and insurance. In highly industrialised countries like the United Kingdom or Belgium, where 50 per cent of the active population are engaged in industry, the value of the output of industry is a larger part of the G.N.P. than in more agricultural countries like France, the U.S.A. or the U.S.S.R., in which the proportion of the active population in industry is nearer 35 per cent. The figures given below are approximate and I have made a lot of simplifying assumptions, but I believe the broad picture to be correct.

In what follows, the word " research " is used to cover what is rather loosely known as " research and development " and by " scientists " I mean persons with university degrees or their equivalents in pure or applied science, including engineers. I recognise there are differences in standards in different countries but have had to ignore this. I have not mentioned all the countries for which information exists, but have tried to select as examples countries where the organisations for carrying out research vary considerably.

The United Kingdom

Research in the United Kingdom is organised relatively simply, primarily through the Government on the one hand and private and nationalised industries on the other. United Kingdom research expenditure in 1955/56 totalled £300 million, or 1·5 per cent of the gross national product. The Government operates through the Defence Departments which maintain their own laboratories and finance substantial amounts of work elsewhere ; the University Grants Committee which provides the majority of finance for university research; and the Lord President of the Council who administers the Agricultural Research Council, the Medical Research Council (with neither of which am I further concerned) and the Department of Scientific and Industrial Research. Of the £300 million mentioned above, £225 million came from the Government ; £90,000,000 was spent in its own laboratories, £15,000,000 in the universities, and £120 million in the research laboratories of nationalised or private industry. The D.S.I.R. spends some £5,000,000 in its own research stations which employ about 1300 qualified scientists. These stations serve those sections of industry which are of great national importance, but which are not easily organised on a co-operative basis, as, for example, building, mechanical engineering, road research, or provide fundamental data, e.g. the National Physical and Chemical Laboratories. The D.S.I.R. also sponsors and supports financially (to the tune of £1,600,000 in 1957) the co-operative research associations which until recently have been a unique feature of British research organisation. There are over forty of these associations, those concerned with non-ferrous metals and with welding being the only ones dealing directly with the industries represented in this Institute. The help from the D.S.I.R. in financing post-graduate research students and in providing special grants for modern and in many cases expensive equipment is of great importance.

Industry spent £70,000,000 of its own money in its research laboratories and some £5,000,000 in the research associations. This total of £75,000,000 is half of 1 per cent of the value of G.N.P. and 0·8 per cent of the value of industrial output, and was 40 per cent of the total amount spent in its own laboratories, the remainder coming from Government contracts, mainly defence.

The distribution of expenditure on research in different sections of industry varies widely. Aircraft is by far the largest, spending in 1956 an amount equal to 35 per cent of its net output on research and development. The average for all other industries is 2 per cent of net output of firms employing more than 100 people, with variations of from 0·1 per cent for the clothing industry to 6·8 per cent for electrical engineering. These, of course, include Government expenditure in industrial laboratories which, on the average, would probably be about half the total expenditure of the manufacturing industries if we presume aircraft is in a special position and is more heavily financed by the Government.

The total number of qualified scientists in the United Kingdom in 1956 was 140,000, of which manufacturing industry employed altogether 55,000. The total number of scientists engaged on research and development was 47,000 if it is assumed that half the time of university teaching staff in science departments is devoted to research. If the 29,000 scientists employed on research and development in British industry are divided in accordance with expenditure between Government-sponsored and industry-financed work we arrive at the conclusion that not more than 10,000 scientists were engaged by British industry in 1956 on research work for its own purposes. If it is assumed, at the other extreme, that all aircraft research and development was paid for by Government there would be some 17,500 scientists engaged in British industry on research for its own purposes—a figure of 15,000 is probably fairly near the truth. The research associations employed 1500 of these and thus constituted an important section of industrial research although their combined incomes equal only 2 per cent of the country's gross research expenditure.

The U.S.A.

In the United States of America no central body existed for the co-ordination of research, like the D.S.I.R. in this country, until a few months ago, when the President established a new Federal Council for Science and Technology to promote closer co-operation among Federal agencies in planning their research programmes. There are over twenty departments and agencies of the Federal Government which include estimates for research in their annual budgets. While departments do a certain amount of research in their own laboratories the general trend is towards decentralisation, e.g. the placing of contracts in universities, research foundations and in industry. The majority of the Government research expenditure is naturally related to defence, and, in 1957, 48 per cent of Government work was carried out in industrial laboratories and 17 per cent in non-profit institutions, mainly the universities.

The total research expenditure in the U.S.A. in 1956 (9000 million dollars) was equivalent to 2·3 per cent of the value of the G.N.P. ; 37 per cent of this (3·3 billion

* Director, British Non-Ferrous Metals Research Association.

dollars or 0·85 per cent of the G.N.P.) was spent by industry for research on its own problems. I have no clear idea how much university research is government or industry sponsored, but it is interesting to note that the independent research institutes, such as Mellon, Battelle and Armour, of which so much is heard, accounted in 1952 for only 2 per cent of the total research expenditure of the U.S.A. About half this was provided by Government and the bulk of the remainder by industry for specific projects, the results of which are confidential to the sponsor. These institutes offer to provide research facilities to the small firm whose resources do not permit the setting up of its own research organisation, but their services are in fact more used by the larger companies.

The U.S.A. has in recent years seen some growth of co-operation in the support of research. In 1953, 20,000,000 dollars was spent by co-operative organisations in this way, the main source of funds being trade associations. The Department of Commerce is said to be trying to promote co-operative research through trade associations, and progress in this direction will be watched with interest.

Out of 750,000 scientists in America the number employed in industry in 1954 was 550,000; of these 157,000 were engaged in research. About 100,000 of them were employed by U.S. industry on its own problems, or about three times as many as were so engaged in this country in proportion to the number of the population (160 million in U.S.A.). An interesting sidelight is that of the total 157,000 scientists engaged in research in the U.S.A. two-thirds are engineers, compared with one-half in the United Kingdom total.

France

Apart from state laboratories the French Government exercises a close control over much research through the Minister for Industry, who is concerned with research in those basic industries such as coal, electricity and gas which are nationalised in France, and the Minister for Education, who not only concerns himself with research in educational institutions but also controls the National Centre of Scientific Research (C.N.R.S.). This organisation covers natural, medical and "humanistic" sciences and employs some 2500 scientists in fifteen large laboratories and a number of smaller ones in which both fundamental and applied researches are carried out with considerable freedom of action to the individual director.

A most interesting development is the Corporate Research Centres set up by branches of industry to serve the trade concerned as a whole or individual undertakings. The state has supervisory functions but, like our D.S.I.R. with Research Associations, rarely interferes with the administrative boards of industrialists. Unlike the research associations, however, they are entirely financed by industry. The methods of financing these centres vary widely but are mainly based on statutory levies which are said to be paid by over 90 per cent of industry. Thus, the French Petroleum Institute (I.F.P.) is financed by a sales tax on petrol, the Foundry Centre (C.T.I.F.) by a levy on turnover added to the invoice for castings, and the Ironworks Research Institute (I.R.S.I.D.) by a sales tax on ordinary steel. The Foundry Centre, of which I know most, has an income from a levy of approximately £500,000 per annum which is equivalent to about £5 per annum for every worker employed in the industry. This Centre probably devotes less than half its resources to research, the main work of its central and nine regional laboratories being in the provision of routine analytical and testing facilities for the entire French foundry industry. It has technical staff capable of assisting foundries with problems encountered in day-to-day production and provides library and information services. The professional research organisations such as the Centres Techniques, over forty in number, have staffs totalling over 3000.

France's total research expenditure amounts to 0·6 per cent of the G.N.P. if we exclude the universities for which figures are not available. Of this amount industry is said to contribute only about 12 per cent, but I suspect the expenditure on the Centres Techniques should be added to this. I have no figures for the proportion of French scientists engaged in research. There seem to be about 150,000 scientists engaged in French industry—much the same proportion as in the United Kingdom—but further breakdown is difficult.

Germany

The Federal German Government plays its part through its own laboratories such as the Physical Technical Federal Institute and through grants to a large number of institutions. The Land governments make some financial contribution to the Max Planck Society for the Promotion of Science. In pre-war days the Institutes of the K.W.I. were well known and after the war thirty-five of these research institutes were re-organised in Western Germany and supported by the eleven Länder which jointly finance the Max Planck Society. Much of the work done in these Max Planck Institutes is financed by industry. For instance, the Verein Deutscher Eisenhüttenleute (the German Iron and Steel Institute) has a number of technical committees which collaborate very closely with the Max Planck Institute for Eisenforschung where the industry, either through the Institute or the individual companies, finances a lot of the work. The directors of these research institutes have complete academic freedom and the visit which we made to Stuttgart two years ago and the Autumn Lecture which we then heard from Dr. Köster will have given members some idea of the kind of work handled in these institutes.

Two other organisations play a part on a national scale, the Forschungsgemeinschaft (an organisation of scientific† and educational institutions) and the Stifterverband (a League of Benefactors for German Science). The first of these receives funds from Government and from subscribers, which are utilised to support individuals working on projects which are beyond their own financial capacity. The second raises money from trade associations and private firms and uses this to finance projects of fundamental or applied nature.

There is a great tendency to encourage donors to contribute to the Stifterverband whose views are listened to with increasing respect by Government and industry in Germany. The number of firms and organisations contributing is between 3000 and 4000, about half of whom have now accepted the new slogan "One per cent of profits to the Stifterverband."

The research work of the industrial laboratories in Germany is now supported by an interesting recent development in co-operative research associations similar in principle to those which have hitherto only existed in the United Kingdom. There are now nearly forty of these associations, but the scope of individual ones is generally rather more restricted. For instance, in the metallurgical field there are six such associations dealing respectively with sheet metal, iron founding, drop forging, casting, hardness and heat treatment, wire drawing and cold rolling. These associations accounted in 1957 for 5 per cent of the industry's total expenditure on research and their future development will be watched with interest.

German industry's research expenditure in these various ways amounted in 1956 to over DM.800 million, about 0·45 per cent of the G.N.P. If we make some estimate of the expenditure of the Länder, the Federal, Land and Municipal Government spend another DM.650 million bringing the whole research expenditure to over 0·8 per cent of the G.N.P.

Holland

While a number of the large industries maintain private research laboratories, Holland is of special interest for the two Government created organisations which look after research—the Organisation for Pure Science (Z.W.O.) grants fellowships and subsidises university research while the Central National Organisation for Applied Scientific Research (T.N.O.) is responsible for ensuring that applied research serves the public need. T.N.O., which is governed half by representatives of the scientific world and half by representatives of industry, runs about forty research institutes, including one devoted to metals and one to corrosion, and supports suitable research projects elsewhere. These institutes are financed partly by direct Government grants, which are usually earmarked for basic researches, and mainly by industrial contributions. These can be used by the institutes for co-operative programmes or for a collection of individually sponsored projects, or both.

Holland has a particularly difficult situation in that 162,000 of its 172,000 firms employ less than ten people and only ninety-four firms employ more than 1000. Co-operation is growing in research and in some instances separate co-operative industrial laboratories have been stimulated by the work of the T.N.O. More than half the total research expenditure of the country in 1956 was incurred by industry.

Scandinavia

As elsewhere, state assistance to research in Scandinavia has increased enormously since the war, although a much larger proportion of the working population is employed in agriculture in those countries than in Great Britain or North America and less research effort is directed towards manufacturing industry. In Norway, the Government finances research by normal grants from the state and by the novel step of the devotion to this purpose of a proportion of the profits of national football pools based, I believe, on United Kingdom league games! The Royal Norwegian Council for Scientific and Industrial Research operates a number of Research Institutes such as atomic energy, seaweed, building, and a Central Institute for Industrial Research, modelled to some extent on the American sponsored institutes, while other similar councils deal with agriculture and humanistic and medical sciences. In addition there are one or two private research organisations with certain limited funds

† It must be remembered that the German word "Wissenschaft" which is generally translated "science" includes humanities.

available for use as grants to research workers and some co-operative research establishments which have made considerable progress since 1948. None of these operate in the metallurgical field.

In Sweden the learned societies headed by the Royal Swedish Academy of Science, supported partly by the state and partly from private funds, to some extent initiate and co-ordinate research and publish results. The state has set up four research councils to follow the research activities in Sweden within their fields and promote research by grants for definite research projects ; the three biggest of these deal with natural science, technical research and medicine.

Research in the universities and institutes of technology, is financed mainly by research councils and state agencies and partly by industry, but there are also a number of research institutes operating in particular fields which are mainly financed by industry. In our own field the Metallografiska Institutet is the interesting one operating in the general (largely ferrous) metallurgical field from Stockholm. The part played by Jernkontoret in Swedish metallurgical research is particularly interesting. This Swedish Iron Masters' Association, founded over 200 years ago, organises research on a considerable scale. The industry provides the funds, Jernkontoret organises a number of research committees and the work is placed in industrial laboratories, works departments and particularly in the Metallografiska Institutet and the various departments of the Royal Institute of Technology in Stockholm.

Denmark relies heavily on universities and on the institutions through which the Academy of the Technical Sciences works. Some twelve such organisations work in fields of technology—the Danish Laboratory for Welding being an example—and most of the working expenses are met by industry. Denmark is also fortunate not only in the well-known product of Carlsberg but in the funds provided by this beneficent organisation for endowing the Carlsberg Foundation for extending knowledge in brewing, biology and in natural sciences.

Russia

One would very much like to compare the picture in Western Europe and in America with that in Russia, but it is difficult to find sufficient facts to make such a statistical comparison. One thing we do know from visits made to Russia and from such information as has been gleaned from all the available sources is that the percentage of research expenditure to G.N.P. is probably at least as high in the U.S.S.R. as it is in the U.S.A. Most of the money comes as an appropriation in the State Budget, with another 20 per cent or so directly from industry. On scientific manpower there is some information which suggests that in 1954 there were 700,000 qualified scientists in Russia, apart from agriculture, of whom about 100,000 were employed in research and development.

The population of Russia (200 million) is larger than that of the U.S.A. and on this basis one might assume that a few years ago the Russian research and development effort was about half that of the U.S.A. Russia is, however, training scientists more rapidly than anyone else. The organisation aims to prepare a scientist highly qualified in a specialist field. The normal course of training is about five and a half years, which includes something like three years of specialisation. In the metallurgical field, specialisation of a ferrous metallurgist might be restricted to the blast-furnace or to open hearth metallurgy. This scheme, it has been stated by Holloman, works well now, but in ten years' time these " narrow people are likely to be unsuited for the further development of the metallurgical industry." The rate at which people trained in this way are turned out is, however, quite striking. In 1954, 70,000 scientists, excluding agriculture and medicine, successfully completed a five and a half year course of training. This compares with 36,000 in the U.S.A. and 11,000 in the United Kingdom. These figures must not be taken as strictly comparable because of differences in standards and qualifications. Research in Russia is carried out mainly in large centralised research laboratories such as those connected with the Academy of Sciences and more particularly the industrial laboratories set up to study the problems of the country and industry as a whole rather than the problems of a particular company or an industrial segment.

Scientists in Russia are, however, treated as persons of importance. Not only are they rewarded more attractively than most other workers, but again, according to Holloman, they can translate research into practice more quickly because the country has greater confidence in scientists and in their contribution to society.

Export Trade Facilities

At the beginning of last year the Federation of British Industries set up a small working party representative of industry generally, to survey the facilities available for assisting firms in the development of their export trade. The principal aim was to identify any " gaps " in education and training arrangements for sales and other staff, and to suggest the necessary action.

THIS week, the Federation of British Industries has published a report entitled *Export Trade Facilities*, which presents the findings of the working party appointed a year ago under the chairmanship of Sir Cecil Weir. The working party's terms of reference were broad. The working party did not attempt to cover the whole field, but decided to take the salesman as the key factor, and to consider export facilities in relation to the training, information and assistance of various kinds which are available. The report is thus divided into three closely related sections, namely, education and training, market investigation, and export trade promotion.

For a start, the report aptly points out that the number of exporters will be increased if manufacturers who now regard export business as a fluctuating " overspill " can be induced to regard overseas territories as an integral part of their total market. Some of the manufacturers who think of exports in overspill terms believe they lack the sales efficiency to penetrate the unknown and operate successfully in an unfamiliar setting. Others may be satisfied with relatively easy profits at home. But it is necessary to get rid of any illusion that there will not be severe competition in the home market. This makes it all the more essential that this country should compete successfully in the domestic markets of others. Under changing conditions a large number of small firms could export more than they have been doing and will have to pay greater attention to this branch of their business. It is important to consider whether the existing facilities are being adequately used by these small firms and how they might be extended and publicised for the benefit of others. At the same time, it is important to bear in mind that the role of the large industrial units in the British economy is increasing in relative significance. Some of the large firms might play a greater part in organising facilities overseas, not only for themselves, but for groups of exporters. As the report comments, the consortium idea has already developed successfully in the nuclear field, the construction of steel plants and the fulfilment of public works contracts. It could well be extended to other appropriate industries.

Education and Training for Export

In the section of the report which deals with education and training, it is observed that much is said about the need for technological education in this country if it is to compete successfully in a changing world. Yet, it is added, technology leading to greater productivity will not avail if it is not accompanied by a corresponding advance in marketing. It can only provide the ammunition for an export campaign. The working party emphasises that a distinction should be made between basic commercial education provided for those intending to embark on a business career and full-time or part-time training provided for those wishing to acquire specialised knowledge relating to their business. It is considered that a sound general education, especially in English, is absolutely essential for any one engaged in overseas marketing. In view of the general advance of education throughout the world and the growing complexity of social, economic and technological conditions, higher education up to university level in the arts or sciences is becoming increasingly desirable in this field in order that Britain may compete successfully with other Western nations. A sound general education, coupled with a natural aptitude for commerce and some practical experience of overseas markets, can and does, the report asserts, produce successful salesmen. Salesmanship is not an exact science; nevertheless, there is a basic specialised knowledge which all export salesmen and export sales managers must have if they are to be successful, and that knowledge can only be obtained through planned courses of instruction.

The report goes on to say that in some areas there is a shortage of teachers and lecturers with a practical, up-to-date knowledge of export marketing problems, although many such people engaged in industry give up some of their leisure time to this work from a sense of public duty. It is not always easy to find lecturers during the day-time when many courses are held. Industry, it is thought, should be urged to release more of its sales staff, including export sales managers, for this purpose as a matter of long-term self-interest. The working party commends the scheme now being organised by the English Speaking Union of the Commonwealth and

the U.S.A. in agreement with the education authorities, for an exchange between staffs of technical colleges in the United Kingdom and the U.S.A. Industry should encourage the development of this scheme which will enable teachers, returning to either country after a period of exchange, to give more informed instruction about technological developments abroad as well as about sales problems in the North American and British markets. This scheme, the report suggests, might well be adapted under similar conditions for other markets. Another recommendation made under this heading in the report is that consideration should be given by the Government, in consultation with the national organisations, to the feasibility of establishing a residential centre for training in the export field. At the same time, the report comments, the responsibility for insufficient utilisation of existing training facilities rests partly upon the individuals themselves, partly upon their employers and partly upon the organisations concerned. The enterprising individual, it says, should make use of available facilities without pressure from others. But it is more likely that he will seek to obtain qualifications if he is encouraged to do so by his employer and by the organisers of these facilities. Employers, it is urged, should be ready within reasonable limits to allow employees to attend classes in business hours. They might also offer some inducement to those who are willing to attend regularly in their spare time, in order to obtain the appropriate qualifications. Moreover, the employer should be encouraged to pay the cost of such training, as he is permitted to charge the expense against tax, whereas the individual employee has to pay for his training out of net income. The working party welcomes the increasing encouragement which employers are giving in this field.

Finally, on the subject of education and training, the report has something to say about languages. It comments on the fact that English may increasingly become a common language throughout the world but, it is added, there are many factors of national prestige as well as commercial convenience which will increasingly tend to put this country at a disadvantage with its competitors if it does not pay comparable attention to foreign languages. The Ministry of Education and the local education authorities, it is observed, should constantly bear in mind the requirements of industry in this respect and see that as high a proportion of young people as possible leave school with a basic knowledge of one or more foreign languages. The working party also expresses itself strongly in favour of extending incentive schemes for the learning of foreign languages.

Export Market Investigation

Any export marketing campaign worthy of the name to-day, the report emphasises, must be based on facts. But, it is added, the approach must be scientific and dynamic. The working party says that export marketing is an operation which must recover the traditional determination to venture into the unknown and to create new markets. The first stage in any market investigation is the acquisition of general data which is more or less accessible to anyone who knows where to look. It calls for an initial " on the spot " investigation by a competent representative or agent. It is virtually useless, the report says, trying to gain a general appreciation of any overseas market without obtaining a report from a representative abroad.

The data required for market intelligence concern the economics of the overseas market territory and the broad characteristics of the particular market, as well as import quotas and duties, the origin and strength of competition, the availability of agents or distributors, the facilities for advertising and other relevant factors. The working party's view is that there exists in this country readily available information to give most manufacturers of consumer goods and many manufacturers of industrial goods a fair picture of individual overseas markets. But the working party is firmly of the opinion that more of the smaller firms should appoint suitable persons on their staffs to take charge of export sales-planning, including the interpretation of market information. It also feels that more frequent interchange of small fact-finding trade missions between this country and others should be promoted by the national organisations and trade associations in co-operation with the Board of Trade. By bringing the producer and the potential user or buyer together, the report comments, by demonstrating how products are being used and applied in Britain and by learning from the visitor how they might have to be modified or adapted to meet his requirements, a fruitful association of common interest is built up.

The report goes on to say that the extended development of this form of market investigation requires to be promoted and operated by organisations based, like the Dollar Exports Council, on the broad interests of the British export trade. The working party thinks that consideration might be given to the setting up of bodies similar to the Dollar Exports Council, supported by industry and backed by the Government, for other major market areas.

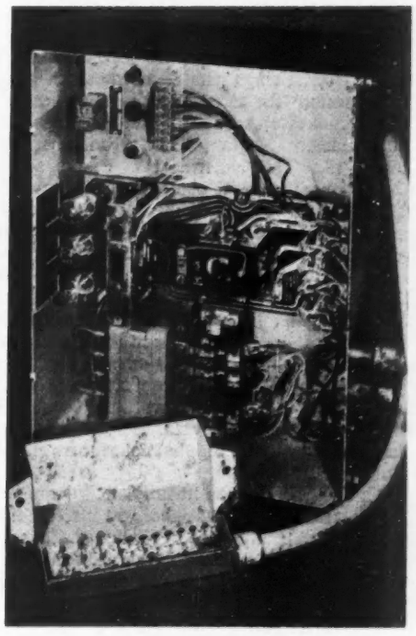
Export Trade Promotion

The final section of the report deals with various aspects of promoting export trade, such as design and packaging, advertising, public relations, and trade fairs and exhibitions. Under this last heading, the working party asserts that, increasingly, the specialised fair will appeal to British exporters as a means of exhibiting and demonstrating their products alongside those of their immediate competitors from other countries. Firms are urged to seek advice from the Board of Trade, either directly or through their trade associations, before committing themselves to participation in overseas trade fairs. There is a tendency, the report says, for British participation in some specialised fairs to be scrappy and unrepresentative, though that is not the case where certain industries are concerned and where the trade associations insist on high standards of display. The more intense character of the competition which will have to be faced makes it particularly desirable not to leave the field open to competitors or to have inadequate displays at specialised fairs in cases where the size of a market has been shown to warrant substantial promotion expenditure.

Finally, the working party says in its report that it does not wish " to reopen the question of a general British Industries Fair." It recommends, however, that urgent consideration be given to the provision of a British exhibition site, not too far from central London, with modern amenities, which would be suitable for specialised international trade fairs on the scale of the large European fairs. This would seem to call for joint financing by Government and industry, the report states, possibly through a limited company empowered to issue shares.

Printed Circuit for Oil Firing Unit

The use of a printed circuit for the control system wiring of a " MacFire " oil firing unit for boilers manufactured by Urquharts (1926), Ltd., Greenford, Middlesex, points to the adoption of this technique for light electrical as well as electronic circuitry. The technique of printed circuits is normally associated with currents not exceeding a few milliamps, but in this case the " Bakelite " copper-clad laminate (grade P17416), which incorporates foil only 0·0015in thick, carries currents of up to 3A and also provides complete integration of the electrical components. The etched circuit was designed by Urquharts (1926), Ltd., in conjunction with Printed Circuits, Ltd., (Stirling Corner, Barnet By-pass, Boreham Wood, Herts)—a member of the L.E.W. group of companies—to avoid complicated wiring and installation errors. Tracing of circuits for fault location is also considerably simplified.



Oil firing unit with printed circuit chassis for central group of components

Components connected to the printed circuit comprise a motor relay, a timing device, circuit protection fuses, signal lights, ignition and flame failure control, and connections taken from it include feeds to a transformer, as seen in the accompanying illustration.

A similar printed circuit technique using " Bakelite " could be used for carrying still heavier currents, since copper foil is readily available up to 0·0045in thick which could often carry currents of 10A or more. Wider adoption of the principle might lead to the production of light electrical components suitable for attachment to the chassis by dip-soldering, as in radio and television receiver construction.

Institution of Structural Engineers.—The annual dinner of the Institution of Structural Engineers was held on April 7, at the Dorchester Hotel. The principal speaker was Mr. Hugh Molson, the Minister of Works, who dilated in a general manner on the importance of the structural engineering profession, and pointed to the increasing importance of this profession by referring to the establishment of chairs in structural engineering at London and Manchester Universities. The president of the Institution, Mr. G. S. McDonald, replied to Mr. Molson's toast. The president-designate, Mr. L. E. Kent, proposed the health of the guests, and Sir Cyril Musgrave, chairman of the Iron and Steel Board, responded.

British Railways 50 c/s Electrification

No. I

Local passenger services between Colchester and the Essex coast at Clacton and Walton are now being operated on the 25kV, 50 c/s single-phase electrification system which eventually will extend from Liverpool Street, through Colchester, to Harwich and Ipswich. In the meantime the area will serve as a proving ground for new rolling stock and techniques to be used in the main-line and London suburban a.c. electrification projects.

THE first public passenger services on British Railways to be operated with 25kV, 50 c/s, single-phase, rolling stock were inaugurated formally on the Colchester–Clacton–Walton section of the Great Eastern line, Eastern Region, British Railways, on April 13. This electrification covers some 24 route-miles and comprises the branch from Colchester to Thorpe-le-Soken, continuing from there in one direction to Clacton on-Sea, and in the other over the single-track line to Frinton-on-Sea and Walton-on-Naze. Outside Colchester there is a triangular junction with a short branch to St. Botolphs (which is nearer to the centre of Colchester than the main-line station) and this branch also has been electrified. Most of the local trains to and from the coast call at St. Botolphs and reverse there to continue their journey by taking the eastern or western curve at the junction.

Current for the electrification is supplied direct at 25kV, single-phase, 50 c/s, by the Central Electricity Generating Board, Eastern Division, to Colchester feeder station, situated approximately a quarter of a mile from Colchester passenger station. This supply is transmitted from two 7½MVA 132/25kV single-phase transformers at the C.E.G.B. substation to the feeder station by means of two 0·25 square inch concentric 25kV single-phase cables. At Colchester feeder station these two cables are connected to a three-section, 15-panel switchboard incorporating two 300MVA incoming supply single-phase oil circuit breakers from which the single-phase busbar is fed. Two bus section switches are connected on the busbar, making the three-section busbar switchboard. Also on this switchboard are the 300MVA, 25kV single-phase track feeder oil circuit breakers for supply to the Colchester–Clacton line and eventually to the main Colchester–Ipswich lines.

Track-sectioning cabins at Alresford, Thorpe-le-Soken and Clacton parallel all sections of the overhead line conductors by means of 150MVA single-phase oil circuit breakers similar to those installed at Colchester feeder station. In addition, eight power-operated switches have been erected at various locations along the line on the overhead equipment structures at strategically-placed overlap spans.

The contractor for the high-voltage switchgear at feeder stations was Fuller Electric, Ltd. High-voltage cables at feeder stations were supplied by Pirelli-General Cable Works, Ltd., and W. T. Henley's Telegraph Works Company, Ltd.

A supervisory equipment for remote control of circuit breakers and power-operated switches has been provided by Standard Telephones and Cables, Ltd. This is the first supervisory system on British Railways to use coded voice-frequency signalling instead of coded d.c. impulses. At present the control is operated from a temporary station adjacent to Colchester feeder station, but it is intended to remove it when the main line to Ipswich is electrified and to concentrate control for the whole area at a new centre. Specially screened star quad pilot cables for the remote control of track switches and of the oil circuit breakers at Alresford, Thorpe-le-Soken and Clacton have been laid in concrete troughing alongside the line in conjunction with the signal and telecommunication cables.

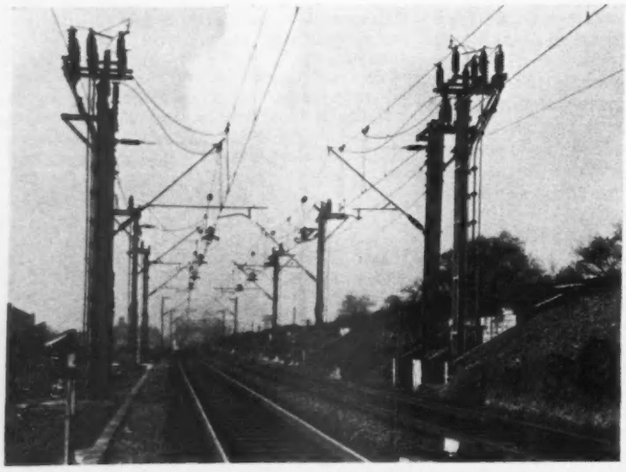
The principal contractor for the overhead equipment was British Insulated Callender's Construction Company, Ltd. Simple catenary construction is employed using a 19/0·083in stranded cadmium copper catenary, and an 0·166 square inch single cadmium copper contact wire attached to the catenary by droppers. Most of the overhead system is of the weight-tensioned type, constant tension being automatically applied by balance weights. At all terminal stations, where running speeds are low, fixed termination simple catenary equipment has been installed. Although the scheme is operating at present on 25kV only, a section has been provided which can be energised experimentally at 6·25kV.

The structures supporting the overhead line equipment are mainly of three kinds: B.F.B. (broad flange beam) section, fabricated lattice and fabricated welded rod. On open route sections of the double-line track the great majority of structures consist of separate B.F.B. masts for each track. Copper-clad steel cantilevers are attached to, and insulated from, the galvanised steel masts. With weight-tensioned equipment, the structure spacing is up to a maximum of 240ft; this spacing is reduced to a maximum of 210ft where fixed termination equipment is used. All overhead line equipment structures are galvanised.

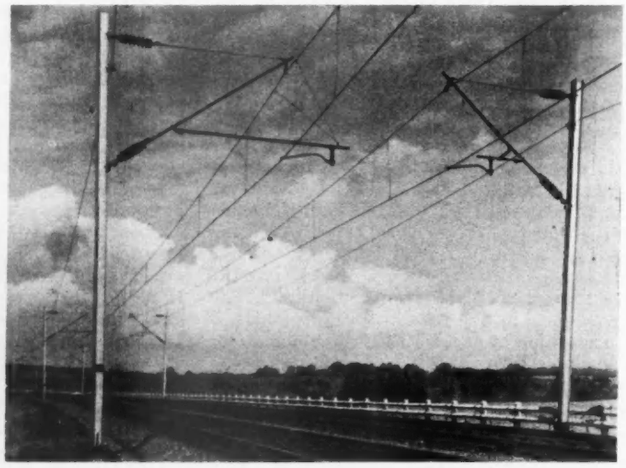
Overlap spans and neutral sections have been provided at convenient points along the line. The a.c. feeder cables from the feeder station have been laid in concrete troughing at surface level to their respective switches mounted on the neutral section structures. Hand-operated isolators associated with overhead conductor equipment were supplied by the Hackbridge and Hewittic Electric Company, Ltd.

The electrical equipment has been designed to the overall requirement of Mr. S. B. Warder, Electrical Engineer to the British Transport Commission and the installation has been carried out under the general direction of Mr. K. J. Cook, Chief Mechanical and Electrical Engineer, Eastern and North Eastern Regions.

Although little heavy civil engineering was involved in this electrification, the work was varied in character, including the alteration of twenty-two bridges. There is a "dead" section of overhead line under one bridge, with provision for cutting off and restoring power when coasting through it, similar to that to be used for voltage changover when in future schemes adjacent sections are electrified at 25kV and 6·25kV. Also involved have been the cutting back of station awnings, alterations to the track layout at certain stations, provision of load gauges and notices at twenty-six level crossings, lengthening of sidings at Colchester and Walton, and the provision of an extra siding at Clacton. In addition to this the steam locomotive shed at Clacton has been converted into a temporary inspection and maintenance depot for electric rolling stock



Isolators and connections to 25kV overhead line near Colchester



Catenaries and contact wires supported by single-track cantilever structures

Train of two four-car units. Electrical equipment is distributed between the leading and second coaches

and a carriage washing plant is to be installed. Temporary shed accommodation for steam locomotives and two small buildings for staff accommodation have also been provided, and a feeder station, control room and a number of relay and track-sectioning cabins were constructed.

The whole of the civil engineering and building works were carried out under the general direction of Mr. A. K. Terriss, M.I.C.E., Chief Civil Engineer, Eastern Region. Contractors concerned in this part of the work were as follows :

Bridges Nos. 1002, Ipswich Road 1032, Cook's Green	Wellerman Brothers, Sheffield	Precast Beams by Anglian Building Products, Ltd., Lenwade, Norfolk
Bridges Nos. 1006, 1014, 1015, 1023 T.S. Cabins	W. and C. French, Ltd., Buckhurst Hill, Essex	Precast Beams by Anglian Building Products, Ltd., Lenwade, Norfolk.
Clacton motive power depot—alterations and additions. Relay rooms	C. H. Chaston, Ltd., Clacton, Essex	—
Feeder station, control room and relay rooms	Cubitt and Gotts, Ipswich	—

The rolling stock at present in service consists of four-coach sets destined ultimately for the London, Tilbury and Southend electrification. This rolling stock is being built at York and Doncaster under the supervision of the Carriage and Wagon Engineer, Eastern and North Eastern Regions, Mr. G. H. Taylor. Power and control equipment is being supplied by the English Electric Company, Ltd. Certain apparatus normally associated with the motor coach has in these trains been transferred to one of the driving trailers. Thus, the driving trailer next to the motor coach carries the battery, the Westinghouse metal rectifier unit serving for battery charging and compressor drive, and the Westinghouse CM38 main compressor. The motor coach carries the oil-cooled main transformer and auxiliaries, oil-cooled reactor tank, two a.c. cases containing tap-changing contactors and secondary group switch, a d.c. switchgear case, and two rectifier cases. Housed in each of the latter are two single-anode excitron rectifiers and a 1·5 h.p., 250V single-phase capacitor-start-and-run fan motor. Each pair of rectifiers provides full-wave rectification for two traction motors in series. By adopting this distribution, all the equipment enumerated is underframe-mounted. A Westinghouse 1·5 h.p. auxiliary battery-operated compressor is fitted in the motor coach for supplying air to the Stone-Faiveley pantograph, Brown-Boveri air-blast circuit breaker and supply changeover switch (25/6·25kV) on preparing a unit for service. A standby high-pressure air bottle is also available for use if the battery is discharged.

The four traction motors in each motor coach are conventional four-pole machines rated at 240 h.p., with tapped fields. On the master controller four running positions are provided, corresponding to those familiar to motormen accustomed to d.c. practice, although the number of tappings used in the automatic accelerating sequence is considerably more than the usual number of d.c. resistance notches.

As a further comparison with d.c. practice, it will be seen that while a static rectifier unit has replaced the customary motor-generator set, auxiliaries peculiar to the a.c. system comprise a transformer radiator fan motor, oil circulating pump motor and two rectifier fan motors, all of which are 1·5 h.p., 240V capacitor-start-and-run machines; and an additional d.c. motor for the auxiliary compressor.

Tap-changing in these units is carried out on the secondary side of the transformer, a practice also adopted in two of the a.c. locomotive designs now being built for British Railways, although two locomotive designs will have an auto-transformer with high-tension tap-changer. The primary of the motor coach transformer is arranged in four equal sections which are connected either in series or parallel by a changeover switch mounted on the transformer tank, according to the supply voltage.

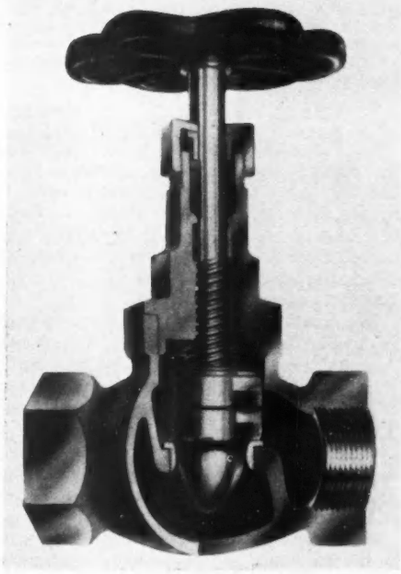
In accommodation, the new rolling stock is similar to that built for the Liverpool Street–Southend service, and has the same formation of driving trailers at each end of a set and a non-driving motor coach. With this arrangement, the motor coach cannot be driven separately from its adjacent trailer. The division of electrical equipment between these two vehicles therefore involves no decrease of flexibility compared with what has been accepted already in d.c. practice on British Railways. The non-driving trailer can be uncoupled to allow units to operate as three-car sets. A four-car set of the new stock seats 363 passengers, and the accommodation comprises centre-gangway, separate compartment, and side-corridor seating arrangements. There are four toilet compartments in a four-car unit. Carriage heaters have been supplied by The General Electric Company, Ltd.

(To be continued)

Steam Control Stop Valve

THE construction of a new control stop valve for use in steam lines, being introduced by Sir W. H. Bailey and Co., Ltd., Albion Works, Patricroft, Manchester, and known as the "Bi-Seat," can be seen in the illustration below. It is designed for controlling a flow of steam at working pressures of up to 300 lb per square inch and temperatures up to 500 deg. Fah., and is particularly intended for use where frequent operation is expected.

On initial opening, the main valve is raised approximately $\frac{1}{16}$ in clear of its flat seat, but the orifice remains sealed by a special spring-loaded parabolic plug. As the unit is opened more fully, the plug is gradually withdrawn from the orifice to provide a streamlined annulus for the passage of steam. This design, it is claimed, makes it virtually impossible for foreign matter to be trapped on the main valve seat. The fine degree of control—from minimum flow to full bore—which is possible allows steam to be admitted slowly to a cold system with full protection for the valve and seat against the direct cutting action of the high velocity steam, thus preventing wire drawing.



"Bi-Seat" control stop valve for steam lines

The same degree of protection is afforded to the seat when the control valve is being closed, because steam is shut off by the parabolic plug before the main valve comes into close contact with it. All working parts of the valves are made of "K Monel" and stainless steel.

PNEUMATICS AND HYDRAULICS EXHIBITION.—An exhibition devoted to pneumatic and hydraulic equipment is to be held at the Alexandra Palace, London, from October 12 to 16 next. During the course of this exhibition a convention will be held at which speakers from this country and overseas will deal with the latest developments in hydraulics and pneumatics. The inaugural meeting of the Fluid Power Association will be held at the same time. The exhibition and convention is being organised by Macfarlane Watson, Ltd., 36, Beauchamp Place, London, S.W.3.

Institution of Naval Architects

ANNUAL SPRING MEETING

No. III—(*Continued from page* 579, *April* 10)

SIR STANLEY GOODALL presided when the meeting was resumed on Wednesday afternoon and the following paper was presented :

AN ANALYSIS OF SHIP-MODEL CORRELATION DATA USING THE 1957 I.T.T.C. LINE

By R. E. CLEMENTS, B.Sc.

SYNOPSIS

The purpose of the paper is not to draw final conclusions as to the roughness allowances but to give a factual report on the results so far obtained. A brief survey is given of the position regarding the estimation of ship resistance up to the time of the 1957 Madrid Conference and the paper touches upon ship predictions and ship trials data and scope of investigations. Tabular statements give comparison of power and revolutions per minute for model and ship for various trials with single and twin-screw ships and there are also ship model correlation curves. There is a discussion of the results and it is noted that the principal conclusion concerning the use of the 1957 I.T.T.C. line is that all corrections are positive and there appears to be no length effect.

DICUSSION

Sir Victor G. Shepheard : The purpose of the paper is the re-analysis, on the basis of the 1957 I.T.T.C. line, of the large mass of model data available for ships on which careful measured mile trials have been conducted by B.S.R.A., and thereby calculating the corresponding 1957 I.T.T.C. " correlation allowances " in each case.

We must be clear in our minds as to what is covered by these correlation allowances. Already there is a tendency by many who should know better, the author among them, to refer to these as " roughness allowances." They are nothing of the sort ; roughness is only one of the many factors which may account for the discrepancy between the 1957 I.T.T.C. prediction and the full-scale trial results.

First there are the errors which may arise in the resistance and propulsion experiments on the models themselves, the subsequent fairing of the results and the additions which have to be made on the naked hull results to allow for appendages, &c. Next there are the errors which are present in the application of the scaling laws for the prediction of ship d.h.p. In the first place this assumes that skin friction and residuary resistance are separable and can be scaled up independently, but no one would claim that this is a sound assumption. Again, the I.T.T.C. line is not an exact scientific formulation of the laws of skin friction, but is an empirical formula intended to serve as a guide in ship-model correlation. Another point to bear in mind is that the I.T.T.C. line itself does not take account of the scaling-up of the form effect on skin friction.

The methods used in the paper for scaling up the propeller and hull efficiency factors could also be a source of appreciable error. No allowance has been made for scale effect on these and it is well known that it does exist. The curves of open water propeller characteristics can show appreciable differences when carried out at different speeds of advance, and if the assumed propeller laws were valid, the curves would all be the same. As regards the hull efficiency factors, i.e. wake and thrust deduction, it has long been known that wake is subject to scale effect, while recent work in Holland and the U.S.A. shows that thrust deduction is also affected in this way.

The recording of data on measured mile trials and the subsequent analysis may also be subject to errors. Variations in results between one ship and another, even if they are sister vessels, cannot therefore be solely ascribed to roughness. It implies that the tank prediction of the ship d.h.p. is precise and that any discrepancy between this and the ship trial results is attributable to the ship. May I make a plea that in future we should refer, not to " roughness allowances " in this connection, but more correctly to " correlation allowances."

I do not wish to minimise the importance of the effect of hull roughness on ship resistance for it is well established that if frictional resistance is to be kept to a reasonable figure, great care must be paid to the surface preparation and coating of the underwater hull when the ship is constructed and throughout its life.

I think it would add much to the interest of this paper if the number of days out of dock were added to the tabular statements, particularly so in the case of the Class " B " trials, where the only information we have is that the time out of dock exceeds twenty days.

Mr. R. N. Newton : It could be inferred from the facts presented that for the ships treated, the 1947 A.T.T.C. line gives better correlation between model and ship than the 1957 I.T.T.C. line, in that the average correction or so-called " roughness allowance " ΔC_f is smaller, and prediction would therefore be expected to be more accurate. Actually the average ΔC_f arrived at, whatever line is chosen as the basis on which to assess it, merely constitutes a correlation factor. The important point is to be consistent and to use the same friction line when comparing forms.

A second inference to be drawn is that accuracy of prediction of performance, judged by the magnitude of the scatter in the results between ships, is poor, whatever line is chosen. For instance, for single-screw all-welded vessels the scatter in the ΔC_f values is 0·0004 if the 1957 I.T.T.C. line is used, and this implies a possible error in prediction of resistance of approximately ± 8 per cent and in speed of approximately ± 4 per cent.

There can be little doubt of the importance of investigating the cause of this scatter, and the obvious explanation has been given by Sir Victor Shepheard, viz., the variation in the several components of ΔC_f. If only some of these can be assessed and allowed for, this would not only reduce the scatter, but also the average value of ΔC_f. In the Class " A " trials, for example, the times out of dock vary up to twenty days, which alone could account for a difference in skin friction resistance of the order of 4 per cent.

Since the 1957 I.T.T.C. line was adopted some attempt has been made at Haslar to break down ΔC_f into a number of components and use whatever data are available to assess them separately and individually. This is being done for ships for which full trial data and model results are available, over a wide range of speed. For each ship, at a number of speeds, the increment of resistance coefficient is being assessed for the following components : (*a*) differences in appendages between model and ship ; (*b*) wind ; (*c*) rough water ; (*d*) fouling of bottom and propeller ; (*e*) surface of " paint " roughness ; (*f*) structural roughness due to plate edges, rivet points, &c. ; (*g*) viscosity effect on wavemaking resistance.

There are, of course, other components which cannot be assessed because of lack of data such as : (*h*) " waviness " of plating ; (*i*) scale effect on wake and augment ; (*j*) cavitation of propeller and appendages ; (*k*) experimental errors.

In the case of an all-welded twin-screw frigate the ΔC_f between the appended ship and the smooth naked model, after allowing for the items (*a*) to (*g*), was reduced from 0·00074 to 0·00013. Corresponding figures for a single-screw all-welded frigate were 0·00063 and 0·00015.

It will be appreciated that to apply this procedure it is imperative to possess detailed information from ship trial records. As the author implies, it is not easy to obtain from past records such detailed information, so that the approach to a further understanding of ΔC_f rests on closer attention to such detail in the future. Equally, the methods of assessment of the components (*a*) to (*g*) of ΔC_f used at the Admiralty Experiment Works are based on intelligent interpretation of the very limited data as yet available. Nevertheless, the fact that such empirical methods afford a fair guarantee of accurate prediction is proof that the principle, at least, is sound.

There is a need for a more intensive attack upon such problems as determining the effect on resistance of surface or paint roughness, scale effect on wake and augment, increase of resistance with time out of dock due to marine growth in different climatic conditions, and so on. There is equal need for adopting a " standard " model technique to account for inexplicable changes in the resistance qualities of the water in individual ship tanks. It is well to note that this alone can account for a scatter of 5 per cent in assessment of resistance and on isolated occasions as much as 14 per cent.

Professor C. W. Prohaska : There is a new friction line committee looking into these correlation factors, and I am pessimistic about the possibilities of it producing anything definite at next year's conference in Madrid. But I hope it will give us more ideas to enable us to cope with this enormous subject.

Naturally, one would like more information on various matters, including wetted surface, and data on propeller loading. Without more information I think it is quite impossible to make practical use of what we have got and I very much hope that the B.S.R.A. will allow their data to be included.

Mr. J. L. Kent : I want to suggest that the research should be carried out in a rather different fashion. To obtain a correlation between model experiments and ship trial results, the paper follows the stereotyped method of dividing the effective horsepower by a model Q.P.C. and multiplying the result by a " factor of ignorance " to deduce the shaft horsepower for the ship. The research has been directed towards stabilising the factor of ignorance.

May I suggest that such statistical research has reached its limit of usefulness and that no closer correlation will be obtained than has been achieved at present by further research along such lines.

The physical conditions in which the model and ship screws work are quite different ; especially in single-screw ships. In practically all single-screw models the disc of the propeller lies wholly within the friction belt, whereas that of the ship's screw has usually from 30 per cent upwards of its disc area outside the friction belt. Consequently the torque curve to a base of revolutions, or slip, whether nominal or apparent, which is obtained from the model experiments will lie completely above that of the torque/slip curve for the ship. At the same revolutions to scale the ship torque is less than that of the model. At the same power to scale both the torque and the revolutions are different, the torque being greater in the model and the revolutions less. It is problematic also whether the model Q.P.C. either at the self-propulsion point, or with the model under-propelled to correct for skin friction, will ever be the same as that of the ship.

Surely all future research in correlation should be directed towards finding a method by which both the thrust and torque lines for the ship can be derived from those obtained from the model experiment data, and obtaining the shaft horsepower revolutions, &c., directly from these curves. Moreover such ship torque/slip curves can be used to predict speed losses from fouling, roughness of hull plating surfaces or rough weather.

Many years ago Mr. Calvert obtained the " wakes " behind a cargo ship, and the late Dr. G. S. Baker extended this work by other experiments carried out at sea. Still more recently the late Dr. Allan and Mr. R. S. Cutland have obtained the velocities of the water within the friction belt with greater accuracy, using better apparatus and spending more time on the research.

Using Dr. Baker's data, I was able to draw an approximate torque/slip line for the ship from model experiment data for a number of vessels with quite good correlation results. But I had to guess the scale effect of the ship to model screw " in open."

I would make a plea to those who direct model research, that when planning future research on this subject the statistical method of finding an ignorance factor be neglected in favour of a drive to bridge the gap between model and ship caused by the different physical conditions in which model screw and ship propeller work. I feel that such an approach will quickly give much more satisfactory results.

Mr. H. Lackenby : This paper is in many respects the 1959 version of the Allan and Canham paper presented to the Institution five years ago under the title " Ship Trial Performance and the Model Prediction." That 1954 paper summarised the results at the time of the joint work which the B.S.R.A. and the N.P.L. had been doing on the correlation of ship and model results. Many more ship trials and correlations have been carried out since, and these have been included in the present paper. The treatment and presentation is generally similar to that adopted in the Allan and Canham paper, except that, in addition to correlations on the Froude and Schoenherr bases, results are given on the 1957 I.T.T.C. line also.

I would underline a point made by Sir Victor Shepheard regarding the fallacy of referring to ship-model differences as " roughness " allowances. Roughness does play an important part, but it gives the misleading impression that scatter and variations are all at the ship end.

Coming to the detailed results and dealing with the Class " A " trials, the author groups these according to different types of shell construction, and averages the results for each group. I have compared these with the corresponding group averages in the 1954 paper and the general picture does not appear to have changed much in spite of the greater number of results now available.

A particular feature of the results in the different shell groups in Mr. Clements' tables is the appreciable scatter of correlation factors within a given group, even among sister ships. The B.S.R.A. has been inclined to the view that much of this was to be ascribed to variations in hull roughness and for the last few years we have been making careful systematic surveys of hull roughness in dry dock before the trial. Considerable progress has been made and there is no doubt that a significant proportion of the scatter can be ascribed to this factor. This sensitivity of ship resistance to small hull roughnesses underlines similar findings from our tests on the " Lucy Ashton." In this connection it is important to bear in mind that the ships considered in the present paper are generally clean new ships and that the variations in hull roughness have been brought about by the way the plates were prepared and the paint applied.

The differences between the averaged correlation factors for the various shell groups I have referred to are not very great, especially in relation to the scatter within a given group. In these circumstances one has to be very careful to make sure that the differences between the means are really significant before drawing definite conclusions. Mr. Canham, of the B.S.R.A., has been examining the results in that light, using statistical methods.

From the point of view of the designer who has to predict measured mile performance to meet contractual obligations, (i) in the first place I think it is important to bear in mind that the correlation factors given in the paper are for ideal trial conditions, that is, flat calm and no wind at all—the ship results have been corrected back to zero wind condition. (ii) Secondly, the designer might feel hesitant about using averaged results, bearing in mind the appreciable scatter. He might feel that he cannot afford to be optimistic and that it would be prudent to take the upper envelope of the curve of correlation factors as shown in the paper.

Clearly, in spite of the additional information that has come to light over the past five years, more work is still required and, in collaboration with the N.P.L., the B.S.R.A. recently got out a forward programme of ship trials, bringing in length categories which have not been dealt with adequately so far, namely, ships under 400ft and over 600ft long.

Mr. H. J. S. Canham : The ship-model correlation problem arises from three sources —the model, the ship and the method of scaling up results. Some indication of the complexity of the problem is gained by studying the results of groups of sister ships, in which errors in model measurements and in scaling up should be largely eliminated.

There are only two groups of material size amongst the single-screw results. First, six all-welded tankers of 530ft between perpendiculars, and secondly, ten tankers of 515ft between perpendiculars, of varied hull construction.

In the first group all the hulls and propellers are identical, all trials were Class " A," but one of the ships was known to have a rough hull for a new ship. In the second group all the hulls are identical in form, but there are differences in propellers ; three of this group have 50 per cent welded hulls, five are 75 per cent welded, and two are all-welded. Only seven of these ships had Class " A " trials ; three of them 50 per cent welded and four were 75 per cent welded.

What is interesting about these two groups is that the variation of ΔC_f in the all-welded group is much larger than in the other group.

Thus, the group in which known differences in hull construction might be expected to lead to increased scatter of results actually exhibits less scatter than a group of hulls of identical construction. Furthermore, in the mixed construction group the average ΔC_f of the 50 per cent welded hulls (three ships) is thirty-seven, whilst that for the 75 per cent welded hulls (four ships) is thirty-nine.

These are some of the reasons why I now believe that average correlation factors obtained by the simple process of grouping hulls of similar construction might be very misleading. A difference of mean ΔC_f of twenty-four between two groups, as shown in the paper (Table 1(*a*)), could arise by chance roughly once in seven times.

I therefore endorse what Mr. Lackenby has said about the advisability of practitioners using an upper envelope ΔC_f value instead of a mean value, and I suggest that the value chosen is obtained statistically so that the risk of it being found inadequate in any particular case is a known quantity. This argument applies even more strongly to the twin-screw results.

It is almost seven years since the B.S.R.A. first carried out a hull roughness survey in connection with the ship-model correlation programme. In approximately two-thirds of the cases covered by the paper, the B.S.R.A. have detailed information about the state of the hulls, including a number of cases where Mr. Clements describes the hull surface as unknown. The classification of roughness by amplitude alone is admittedly crude, but having regard to the stated wavelength to which it applies it might be deemed somewhat less crude than the classification of roughness by methods of hull construction in which the term " all-welded " makes no distinction between the riveting or welding of the frames to the shell.

Mr. D. I. Moor : I view this problem from two completely different angles. First, we have got to be able to predict with specific accuracy what a ship will do. Secondly, I endorse the view that we have got to get down to the actual figures of ship-model correlation, and not run around with what is called an ignorance factor.

Mr. C. A. Lyster : This paper has left in my mind a sense of vagueness which is not at all appropriate to a scientific paper. I endorse the pleas that have been made for more complete data.

A person having no inside information on the methods used at the N.P.L. has no means of knowing exactly how these results were analysed. The Q.P.C. in particular is vague ; the loading at which the Q.P.C. is obtained and the value used cannot be estimated. It is pointed out that by comparison with Allan and Canham's paper there are differences for certain ships, and this implies that the method of analysis has been changed. I think it is encumbent on Mr. Clements, if the methods used have been changed, to say where and to give his methods in more detail.

My personal belief in connection with Mr. Clements' conclusions is that the correlation factor does change with length and will not remain constant on the basis of length when the I.T.T.C. line moves.

Dr. G. Hughes : May I deal with one or

two of the technical difficulties and remove a little of the pessimism ? For instance, in the revolutions correlation (Table I and other tables) we find a surprising consistency. It is a correlation of the revolutions obtained on the single-screw ships compared with those on the model for the same power absorption by the propeller, assuming the model propeller is scaled up by a correction. This consistency, despite the variation of the type of hull construction and the condition of the hull surfaces, is an indication that we have here some excellent data. It shows, to me, that there is an amazing consistency in what would be a combined wake and propeller scale effect, only a matter of a few per cent of revolutions, between the power and the revolutions relationship.

With regard to the twin-screw ships, Mr. Clements has mentioned that the correlation appears to be on the average about 4 to 8 per cent less than in the case of single-screw ships. Also he mentioned that the full bottom allowance has been used. If that allowance is reduced, then we shall get a less prediction from the model, consequently a rather greater correlation factor for the twin-screw ship, and we shall bring single-screw and twin-screw ships more or less into agreement, for the loaded condition. On the average they will want the same correlation factor as for single-screw ships and, again, I think that is a feature which points to good and accurate data.

Professor E. V. Telfer : I think Mr. Clements has been wrongly advised as to what took place in Madrid. We looked forward to a 1960 line and possibly a 1963 line ; whether the latter will be the final one we do not know. But we only agreed to have one line now so that we can study our own problems ; the 1957 line was not to be a line for ever, but we should study our own lines on the same basis.

(*To be continued*)

150MW Nuclear Power Station for Tokai-Mura, Japan

JAPAN'S first atomic power station is to be built by The General Electric Company, Ltd., of England, in association with Simon-Carves, Ltd., at Tokai-Mura, about 70 miles north-east of Tokio, as announced in a letter of intent issued by the Japan Atomic Power Company on April 3. This letter of intent recalls the recent announcement (THE ENGINEER, March 6, 1959, page 389), that the Japan Atomic Power Company had opened exclusive negotiations with the G.E.C. for the supply of a 150MW nuclear power station. It is expected that the final details of the contract, the value of which is likely to approach £20,000,000, will be settled later in the year. The station will take approximately four years to build and is expected to be in full operation in 1963.

For the final stages of the negotiations prior to the placing of the letter of intent, a Japanese delegation, led by Mr. Tamaki Ipponmatsu, vice-president of J.A.P.C., arrived in this country on March 24. The delegation has also received from Lord Plowden, chairman of the United Kingdom Atomic Energy Authority, a letter of intent to supply fuel for the Tokai-Mura station. At the same time, a technical assistance agreement between the Japan Atomic Power Company and the United Kingdom Atomic Energy Authority was signed by Dr. Ipponmatsu and Mr. J. B. W. Cunningham, Director of Industrial Power in the Authority's Industrial Group.

The design submitted by the G.E.C. in collaboration with Simon-Carves, Ltd., is for a 150MW single-reactor power station. In its basic elements the reactor is similar to those already being built for the British nuclear power programme. The natural uranium fuel elements are mounted in vertical channels through the reactor core which is built up from interlocking graphite bricks and tiles weighing a total of almost 1500 tons. There are 2056 fuel channels, each containing eight fuel elements. The core is completely enclosed in a spherical pressure vessel having an internal diameter of 62ft, and is surrounded by a concrete biological shield approximately 10ft thick. Carbon dioxide gas is circulated through 6ft diameter ducts connecting the pressure vessel to four steam-raising units, two on each side of the reactor building, and the steam so generated drives two 85MW turbo-generators in the turbine hall.

Charging and discharging of fuel elements can be carried out while the reactor is on full load by means of a single machine operating above the reactor. The reactor is provided with the usual control system employing neutron-absorbing control rods which can be raised and lowered in vertical channels interposed between the fuel channels through the core. In addition, however, an independent alternative shut-down device, which can be tripped manually and which operates automatically under severe earthquake conditions, has been incorporated in the design. Balls of boron steel about 1in in diameter are released from containers and fall under gravity into channels in the core, having precisely the same effect as the conventional arrangement of boron rods. This device is effective even in the event of movement of the core relative to the pressure vessel. Overall control of the operation of the complete power station is effected from a central control room in the reactor building.

The design is subject to stringent requirements laid down by the purchaser to ensure the safety of the installation under the most severe earthquake conditions. One requirement is to ensure the integrity of the reactor building and its associated steam-raising plant as a complete unit so that no breach can occur in the gas circuits ; accordingly, the concrete substructures supporting the steam-raising units are carried on the main reactor foundation raft to ensure uniformity of movement during earthquakes. In addition, the support system for the gas ducts connecting the reactor pressure vessel to the steam-raising units is designed so that the stresses in the ducts and in their junctions with the vessel are always maintained at safe levels.

Another safety measure is that the reactor building itself houses all the plant necessary to guarantee the removal of all heat generated within the core, even if severe earthquake shocks should cause the fracture of all pipe connections between the reactor building and the turbine hall.

The reactor core, including the graphite reflector which surrounds the core proper, is a thirty-two-sided structure. It is supported inside the pressure vessel on a steel grid of " egg-box " construction and the graphite blocks are held in place by a system of restraints in the form of a framework which encircles the whole core. This framework is designed to hold the core accurately in position even during a severe earthquake.

The 62ft diameter spherical pressure vessel which encloses the reactor core is fabricated from 3¼in plates of steel specially selected to withstand the effects of prolonged irradiation. The sphere is supported on a cylindrical steel skirt, and a further skirt is welded to the vessel near the top. This upper skirt is anchored to the biological shield as a precaution against disturbance during earthquakes (as illustrated on page 389 *ante*).

Vertical standpipes connected to the top of the sphere pass upwards through the top shield, providing a means of access to the reactor core for control mechanisms and charge/discharge equipment. Further standpipes house mechanisms capable of detecting any displacement of the core, pressure vessel or support grid due to earthquakes and of shutting down the reactor before the safety of the installation is jeopardised.

The fuel elements are fabricated from natural uranium metal encased in specially finned cans of magnesium alloy. Each element is individually supported inside its own graphite sleeve, an arrangement originated by G.E.C. The weight of the stack of elements in a channel is thus transmitted through the sleeves so that stresses on the fuel rods themselves are kept to a minimum. By making the sleeves from a specially treated graphite which has a very low permeability to the coolant gas, it has proved possible to maintain the main moderator graphite at a temperature such that no significant storage of Wigner energy occurs during the life of the reactor.

Since the fuel in this reactor is charged and discharged from above, each element is provided with a grappling system which can be gripped by the charge machine grab. This device is made of a zirconium alloy and is designed so that the cartridge itself cannot be damaged during refuelling operations.

In this reactor, the charging and discharging of fuel elements are carried out from above the reactor. It will be recalled that G.E.C. pioneered the development of bottom charge/discharge equipment but it was decided to depart from this principle to meet the special local circumstances : by adopting top charging arrangements, the centre of gravity of the reactor building is lowered, thus improving its stability under earthquake conditions.

All normal refuelling operations are carried out, while the reactor is on full load and under pressure, by a single machine travelling on a gantry above the top concrete shield. The same machine is also used for reactor servicing, including the planned maintenance of control mechanisms. A duplicate machine is installed to provide extra facilities during start-up and to allow the first to be withdrawn for maintenance.

Each charge machine is remotely controlled by a single operator from a desk housed in a control room at the edge of the pile cap. To ensure the correct functioning of the machine, highly developed sequence-control equipment is provided, the possibility of error being further reduced by the employment of a punched-card system for setting the requisite interlocks for any given operation. The operator can follow the working of the machine by means of mimic diagrams and closed-circuit television equipment.

For all normal reactor-control functions, including emergency trips, the usual system of control rods is employed. Each rod is suspended from a stainless-steel wire rope wound on an electrically-driven drum mounted in an extension to the associated top standpipe. The driving system provides accurate control of the rod's position in the core, and of its rate of movement at all times. As already mentioned, there is also an independent shut-down system of boron balls to operate in the unlikely event of the core being greatly deranged by a violent earthquake.

Each of the four steam-raising units designed by Simon-Carves, Ltd., incorporates h.p. and l.p. evaporators with economiser and superheater sections. The banks of specially designed finned tubes which make up these various sections are mounted in a cylindrical pressure shell, 84ft high and with an internal diameter of 21ft 6in. The tube supports and also the skirt on which the complete unit is carried are designed to withstand earthquake shocks.

The carbon dioxide coolant is circulated through the reactor system by single-stage centrifugal blowers. One blower is mounted in the base of the pressure shell of each of the four steam-raising units, thus avoiding the need for large separate pressure casings. Each blower is driven by a steam turbine.

In the turbine hall there are two 85MW turbo-generators, each comprising a dual-pressure steam turbine driving a hydrogen-cooled alternator incorporating a highly developed system of direct cooling for the rotor. Apart from the normal steam condensers, dump condensing plant is provided for duty during start-up and shut-down. The circulating water for all this plant is drawn from the Kuji River.

SHORTER REPORTS

RAISING THE KAFUE BRIDGE

WE have recently recorded in these columns several examples of the use of hydraulic jacks to lift or translate major engineering structures. Another interesting example of this kind comes from Northern Rhodesia where the thirteen-span railway bridge over the Kafue river has been raised 7ft without interruption to rail traffic.

The bridge was built in 1906 by Pauling and Co., and consists of thirteen 100ft clear spans. When the Kafue river floods, large masses of rushes, undergrowth and small trees—known as "sudd"—are uplifted from swampy regions and float downstream. During the exceptional floods of 1925–26 the river inundated the bottom booms of the spans and packed sudd against them and the safety of the bridge was gravely threatened. A 5ft lift was therefore undertaken the following year. In 1948 and 1952 yet higher floods again endangered the structure. The question of a further lift was then referred to the railway's consulting engineers, Messrs. Freeman, Fox and Partners, who, after taking into account the hydrological data then available and also the backwater effect of the then projected Kafue hydro-electric scheme 20 miles downstream, recommended a lift of 7ft; 3ft of this was due to the hydro-electric scheme which, however, has not yet been built.

The original foundations were known to be weak and had to be strengthened before the proposed lifting could be done. The work was therefore planned in two stages, the first being the strengthening of the foundations and the second being the actual 7ft lift of the superstructure.

Foundations

Steel-sheet-piling was driven to form a cofferdam round each pier. The tops of the piles were above the low water level, and the cofferdams were then pumped out and excavated almost to the level of the underside of the existing foundations. The enclosure was then filled with mass concrete and raised a further 6ft to form a collar round the old pier.

Numerous obstructions were met during the course of the work and chief amongst them was the presence of a large mound of bagged concrete surrounding each pier, laid in previous years as a protection for the footings of the piers again scouring. It was necessary to keep clearance of these only a little ahead of the pile driving so that an early rise of the water and consequent stoppage of operations would not leave some piers unprotected in the following flood season. The bags were removed by a standard stoping bucket connected through an A-frame and snatch block on the deck of the bridge to a diesel-driven double-drum mining hoist mounted on a steel pontoon.

For the piling, the limited headroom dictated special arrangements. Double R.S.J. runways were suspended from the main booms. Each pile was placed in turn between the two joists, and suspended on a heavy bolt fitted with low grade ball bearings at each end to travel on the runway flanges. The pile was then rolled towards the centre of the bridge and the next pile was interlocked and placed in a similar manner. Thus a roller shutter of suspended piles was formed across the face of the pier. Steel walings were cantilevered out on supporting brackets from the pier and the panel was ready for driving.

A side cradle was used to start driving the piles, one at a time, until sufficient headroom had been obtained for the piling hammer to be carried on a chain block using the joists as a runway. Two panels of piles were thus driven, one on each side of the pier. Two sets of inside and outside walings were then bolted to the driven piles at the two different levels and these walings were used to pitch all the piles to complete the sides and ends. All piles in one end unit were interlocked and pitched before further driving took place, thus avoiding closure difficulties. All piling was handled on gin poles, one at each end of the pier clear of the bridge, with luffing tackles taken back to the top booms of the adjacent spans. Lifting was by compressed air winch mounted on the end rakers of the spans.

Guide plates were made at the site for the piling hammer, which was fitted with remote control placed conveniently for the winch operator. Piles were floated out on a raft of oil drums and it was possible for one skilled operator at the air winch to control all lifting, pitching and driving. Concrete was trammed to the cofferdams along a catwalk erected outside the downstream girders.

The Lift

The lift was carried out in a series of 12in steps using a number of Duff Norton worm gear jacks supplied by the Consolidated Pneumatic Tool Company. These jacks were governor-controlled and had lifting capacities of 50 tons each, and were used in conjunction with specially prepared grillages which were inserted under each bearing after every lift. These grillages were clamped down to the old holding down bolts and each tier was bolted to the tier below at the intersections. The grillages were designed to carry the live load reactions under speed restriction without concrete casing.

Each span was lifted independently and the sequence of operations began by raising the north end of the span by 6in and placing it on hardwood packs under the end cross girder. The south end was lifted in two stages of 6in each and its grillages were set. A further lift of 6in was then made at the north end and the grillages placed in position there. By carrying out each lift in this way end drift was entirely eliminated, no end drift occurring on any span throughout the total 7ft lift.

Seven crews were employed simultaneously across the thirteen spans so that alternate spans were raised together and one crew was available, after completing one span, to work back along the bridge, correcting any side drift and assisting delayed crews.

Before lifting began, the track on the approach embankment was "humped" to a height of half the total lift so that, when lifting started, there was a down grade to the bridge. At each lift it was only necessary to lift and pack the track between the hump and the bridge; thus, after the final lift the bridge was at the top of a smooth grade. The lift was later extended along the approaches in each direction. The mass concrete pier top extensions were carried up after every two lifts, encasing the grillages.

Before the main lifting work began, a short lift of 3in was effected by raising one span at a time. This 3in lift was necessary to remove the old cast iron bed plates, many of which were cracked and broken. The opportunity was also taken of renewing the old sliding bearings with articulated 1in bearings at the fixed ends and large diameter single segmental rollers at the expansion ends. The grade of 1 in 400 which this lift entailed was carried forward, span by span, and was of no consequence with a speed restriction on the bridge.

Whilst the technical problems encountered were relatively simple, the project is of interest due to the variety of practical difficulties encountered in carrying out the work, especially with a river steadily rising, in the latter stages of the cofferdam work, at the rate of 3ft in fifteen days. So tight was the schedule that water in the rising river just topped the level of the concrete in the last cofferdam twelve hours after it was completed. The most exacting requirement, however, was the need for a full service to be maintained without interruption during the work, whilst completing such unpredictable tasks, as for example, the breaking out of the old bearings and the assembly and emplacement of the new. The resident engineer for the railway was Mr. W. L. Bonny and the whole of the work described was executed by direct labour under his charge.

Mobile Hydraulic Test Equipment

Much use is made of hydraulic systems on mobile equipments, and in many cases the conditions met with in operation of the hydraulic devices cannot be reproduced with the vehicle stationary: an obvious example is the automatic draught control of the Fordson "Dexta," illustrated below.

Thus to observe the functioning of the hydraulic circuit, either telemetry must be employed, or the test equipment must be capable of travelling with the plant. The latter principle clearly involves far less difficulty and danger of the information being degraded, and has been adopted by the development section of the engineering department of the industrial hydraulics division of the Plessey Company, Ltd., in building a mobile research unit aboard a Land-Rover.

The main intelligence handling equipment comprises two cathode-ray oscilloscopes: for recording results moving-film cameras, with nine film speeds between 0·05in and 25in per second,

A test in progress on the automatic draught control of a "Dexta"

are used. A dark box, within which a film can be transferred from cassette to developing reel, and a film drier are provided. The electrical power needed is supplied by a Petbow constant-frequency petrol generator carried just within the nearside door.

The parameters normally monitored are pressures, and the pick-offs used are resistive transducers. The transducers are connected into a bridge circuit carried on the subject equipment—in the illustration it can be seen slung from the operator's harness—and the output signal is passed by cables to the amplifiers of the c.r.o.'s. It is found that, by calibrating the equipment before each test, reliable results can be achieved with this d.c. signalling arrangement.

The test illustrated is interesting as demonstrating the value of this mobile facility. Hydraulic circuits frequently are used only when the plant main engine is lightly loaded—e.g. a stacking truck hoists when standing still—and so ample power is available for them. The "Quantrol" on a Fordson tractor is intended to allow the maximum power to be generated continuously at the driving wheels, and if the surface is good this maximum will be set by the power available from the engine. Hence power is grudged to the "Quantrol" circuit, and any parasitic pressure losses must be eliminated. In this case a J. Langham Thompson transducer is set into the control mechanism, seen between the driver's knees, while the draught forces are measured by using a hydraulic ram as one of the members in the plough linkage and monitoring the pressure in it. The tractor driver communicates with the development engineer in the Land Rover by a two-way telephone circuit.

Fibre Filter for Acid Mists and Fumes

We are informed that Mancuna Engineering, Ltd., Denton, Manchester, was granted a licence for the manufacture and marketing of a new fibre filter developed by Mr. G. Lowrie Fairs, of Imperial Chemical Industries, Ltd., general chemical division. This filter, it is stated, virtually eliminates the emission of very fine acid mist particles from the tail gases of major acid producing plant.

A very high degree of efficiency which is achieved with this new filter is due to the employment as the filter medium of fine diameter fibres which possess hydrophobic characteristics. This characteristic results in the impingement on the fibres of discrete droplets of very fine liquid particles and in a very free dispersion and drainage

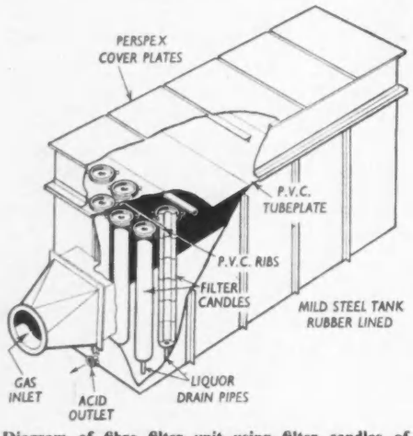


Diagram of fibre filter unit using filter candles of "Terylene" fibres

of liquid through the mass of fibre. Experimental work has been carried out primarily with glass fibre and "Terylene."

In the case of glass fibre it is necessary to treat the fibre with a silicone such as I.C.I. silicone "M441" in order to provide the hydrophobic characteristics on which the operation of the filter depends. A 2in thick pad is formed either in the shape of a flat disc or in candle form; the pad being moulded at a temperature in the range of 400/550 deg. Cent. In the case of "Terylene" the effective temperature is 140/160 deg. Cent.

It is stated that the filters have been extensively tested at pilot plant stage in the elimination of mist from gases containing very fine sulphuric acid mist. The performance where the acid mist comprises droplets which are 100 per cent below two microns has been such that an inlet concentration of 0·1g H_2SO_4 per cubic metre has been reduced to an emission to atmosphere of a mist concentration of 0·0005/0·0007g H_2SO_4 per cubic metre. A very significant feature of this equipment is that the emission of mists from the outlet of the filter does not increase where there is a temporary or fluctuating increase in the inlet concentration. This self-compensating characteristic over a wide range of gas flow rate and mist concentration is a very important development in filtration equipment of this kind and is clearly of the greatest significance.

For the assessment of a mist emission problem special sampling methods have been devised to determine the particle size distribution on which is determined the packing density required in the preforming of the filter elements. Engineers on the staff of Mancuna Engineering, Ltd., have been trained by Imperial Chemical Industries, Ltd., in the appropriate sampling methods, using isokinetic techniques.

One proposed design of unit being developed by the firm is illustrated in the diagram which shows an assembly of preformed filter candles. At present work is being concentrated on the application of "Terylene" fibres as the filter medium, this fibre being very resistant to normal acid conditions met in tail gas emissions, and providing certain process advantages in that no silicone treatment is required, the fibre being intrinsically hydrophobic.

The unit as illustrated comprises an assembly of blocks of standard filter candles each consisting of six 10in long elements sealed together to form one composite candle. Inclusive of the steel tank and top outlet chamber, the unit will stand approximately 6ft high, though some 13ft of headroom will be necessary to permit the withdrawal of the candles for any necessary servicing or replacement. It is intended that units should be introduced into existing plant through ducts which will incorporate "U" bends which can be used as individual water seals. The liquid removed from the gas discharges down the centre core of the candle and is removed from the tank through a simple acid outlet. Should there be any breakdown in one or other of the candles, mist channelling through the filter pad into the centre core of the candle will be clearly visible through transparent plastic cover plates. Should such an event occur, the unit can be isolated by flooding with water prior to the safe removal of the candles for inspection and/or replacement. It is anticipated that one candle of six elements with a 10in w.g. pressure drop will handle some 200 cubic feet of air per minute. A period of up to twenty-four hours is required from the start up of the filter before maximum efficiency is achieved owing to the necessity to build up an adequate liquor content in the fibres.

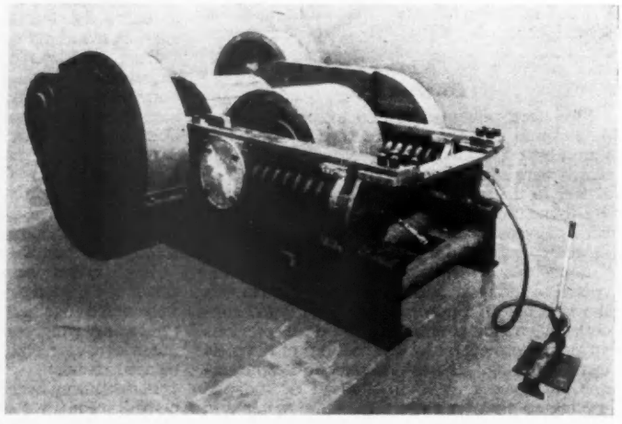
The unit described is to be sold under the trade name "Mancuna-Mistex," while a further irrigated form of the filter will be called the "Mancuna-Fumex." The application of the irrigated form of the fibre filter will permit the recovery of mists where the acid concentration would normally be such as to damage the filter medium. A further significant potential is that very fine fumes which can be physically dissolved, emulsified or dispersed, or form a colloidal suspension in liquid, can be efficiently eliminated from a gas stream. As an indication of the performance of the "Mancuna-Fumex" in its application to fume removal, a pilot plant employing "Terylene" polyester fibre preformed into a flat cylindrical mat where the filter medium was continuously irrigated with water was applied to a fume containing fine particles of sodium monoxide, together with calcium chloride, sodium chloride and chlorine. This fume was obtained in the replacement of diaphragms in cells for the electrolysis of fused mixtures of sodium chloride and calcium chloride. The top particle size of the contaminating particles was less than 4½ microns, 90 per cent by weight being less than 3½ microns, and 50 per cent by weight being less than 2 microns. The concentration of particles in the fume varied between 0·25 g and 1 g per cubic metre of air. The filter, it is stated, was applied to remove this fume for a period of two months with no detectable amount of solid found in the exit gas—any solid present in the exit gas being present in quantities certainly less than 0·001 g per cubic metre.

Roll Crusher

An addition to the roller bearing crushing rolls in the "Rollsizer" series made by Frederick Parker, Ltd., Leicester, is a machine fitted with a hand-operated hydraulic pump for spring tension adjustment purposes. The new 30in by 24in machine shown in our illustration has outputs of 32 to 75 tons an hour and it has been introduced to meet the demand for stone crushed to minus ¾in, although it is adjustable to produce smaller or larger sizes.

The machine has a fabricated steel frame and rolls of manganese steel, the shafts of which run in heavy-duty, self-aligning spherical roller bearings, labyrinth sealed against dust. Roll settings are obtained by inserting or removing small shims.

On the crusher the shells can be either plain or serrated on both rolls. By using a combination of different designs of shells, the duty of the machine can be varied. The use of two plain shells gives a large proportion of very fine aggregate but needs a reduction in feed size.



Roll crusher with hand-operated hydraulic pump for spring tension adjustment

Proposed Air Liners

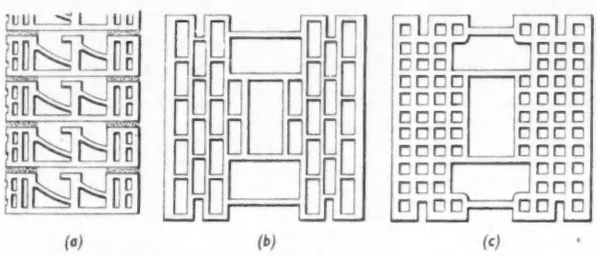
On Monday last, the Minister of Supply was asked in the House of Commons when he would make public the recommendations of the research study group investigating the economics of supersonic air liners. Mr. Aubrey Jones did not answer beyond observing that the Supersonic Transport Aircraft Committee had recommended that detailed design work should be undertaken on two projects:

(i) An aeroplane carrying 150 passengers on the non-stop London-New York route, cruising at about twice the speed of sound; and

(ii) A smaller aeroplane, carrying 100 passengers, for stage lengths of up to 1500 statute miles cruising at 1·2 times the speed of sound.

Building Trials With Large Perforated Bricks

NEWS has just come from the Building Research Station of building trials in progress with perforated bricks designed by the Station. This matter was first referred to in the Station's most recent annual report, published last July. It was then stated that " work on perforated and hollow bricks and blocks has been directed mainly to developing patterns of brick that would be suitable for use in Britain, where facing brickwork is a tradition not lightly to be surrendered and where the rendered finishes so widely used on the Continent cannot be accepted as the universal solution of the problem of rain penetration. Two brickmakers have made trial batches of a horizontally perforated brick designed by the Station, and these have been used to build test walls for the determination of compressive strength and for rain penetration tests. The brick measures 13⅛in by 8⅝in by 2⅝in, and is provided with a central hand-hold and two grooves in the upper surface to interrupt the horizontal joint and so hinder rain penetration.



(Left) (a) End elevation of wall with 13⅛in long horizontally perforated bricks. (b) Vertically perforated " V5 " brick as shown in second illustration. (c) " V6 " vertically perforated brick. (Right) Laying a 9in wall with the " V5 " bricks

A 9in wall of these bricks showed much greater resistance to rain penetration than a 9in wall of ordinary common bricks, though it was inferior to a normal 11in cavity wall. Tests have also been made on vertically perforated bricks laid with a divided joint, and these, too, have given encouraging results in the rain penetration test. Development is continuing."

The 13⅛in brick with horizontal perforations is illustrated in the accompanying diagram. However, it would appear that greater success is being obtained with a slightly smaller brick with vertical perforations. Two versions of this brick, known as " V5 " and " V6," are also illustrated, and we show these bricks being laid. The following is the Station's account of work up to the present.

" A hollow clay brick—which forms a cavity wall in one unit without ties—has been developed at the Station. The hollow brick completely changes the traditional British pattern of clay brick which has existed in its present form for hundreds of years. Yet only a comparatively small change in technique will be required by the bricklayer. A group of four bungalows, designed by Mr. F. B. Pooley, F.R.I.B.A., consultant architect to the Aylesbury Borough Council, is the first building in this country to be constructed with the new type of bricks.

" The bricks are perforated and are therefore lighter than the standard solid brick, volume for volume ; this should lead to quicker laying. The air spaces in the bricks provide the necessary thermal insulation and assist the manufacturer in drying and firing. The design also lends itself to mechanised production. Two firms have so far co-operated in the development. The Western Counties Brick Company has manufactured the earlier design of horizontally perforated brick and has built an office block with it. The Sussex and Dorking Brick Company, Ltd., has manufactured enough of the vertically perforated bricks for the bungalows at Aylesbury.

" Research work included a study of bricks and brickworks on the Continent, where hollow clay blocks have been used for many years. But the new bricks had to be designed to meet British conditions. Continental brickwork is nearly always rendered externally for rain exclusion. In this country, however, we have a tradition of facing brickwork and the need to maintain this yet provide rain-resistant bricks is an example of the research problems. It was also necessary to make the new bricks strong enough for use in place of the existing type of cavity wall. Resistance to fire was another requirement.

" In principle, it is simple to remedy the shortcomings of the standard solid brick. In practice, however, there are many pitfalls and in the last 100 years or so most of the new designs invented and patented have either never been manufactured or have failed to become established.

" In designing the bricks—called " V5 "—the Building Research Station believes that it has met these requirements. The standard formats recommended and used at Aylesbury are 8⅝in by 8⅝in by 2⅝in and 8⅝in by 8⅝in by 4⅛in, so that with ⅜in bed and vertical joints the design and building sizes are respectively 9in by 9in by 3in and 9in by 9in by 4½in. This gives compatibility with the form of existing bricks and involves the least interference with existing building techniques. The 9in by 9in by 3in format, for example, with its hollowed-out hand-hold in the centre and 50 per cent air space by perforation, can be laid as easily as one normal brick because it is only the same weight although twice the volume.

" A whole range of other sizes, including one or two 13½in long, can be produced to give greater scope to the architect. In other words, the principle may be applied in providing the designer with at least two different lengths and several different course thicknesses. Obviously, a perforated brick must be handled with more care and the Station is now studying methods of extending its brick-packaging system to include this new development."

High-Speed Photo-Printing Machine

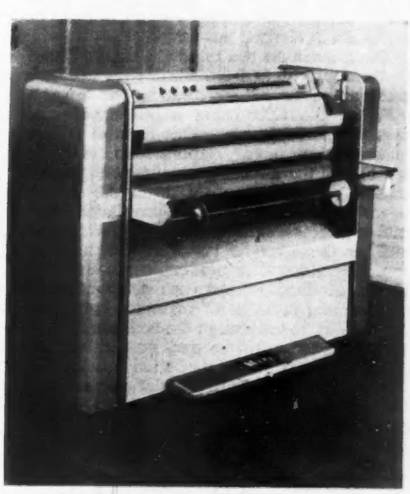
A NEW synchronised combination printing and ammonia developing machine introduced by the Nig Manufacturing Company, Ltd., Dane Street, London, W.C.1, is designed to produce prints at speeds up to 40ft per minute. This " Zephyr " machine, as it is known, handles tracings up to 44in wide, and can be arranged to deliver the prints at the rear or the front. When printing continuously from the roll the paper is delivered print side up from the rear of the machine to facilitate the cropping off of individual drawings.

As was demonstrated recently by the makers, this photo-printer produces a high-quality print even when operating at its highest speed of 40ft per minute. The speed and efficiency of the machine, it is stated, has been made possible by dispensing with the perforated metal plate or roller methods of supplying the ammonia vapour for developing, and the introduction of what is termed a " wind tunnel " for this purpose. By means of this " wind tunnel " ammonia vapour is delivered under pressure at high speed on to the sensitised surface of the paper.

The new photo-printer, which is illustrated below, has in its printing section a 3kW quartz lamp mounted in a 6in diameter revolving glass cylinder. This cylinder is cooled by a large volume of filtered air which is continuously pumped through it and exhausted through ducting clear of the machine. From the printing section the paper, either in the required size or as a continuous roll, is fed by rollers through a sealed chamber above. In this chamber a continuous stream of ammonia vapour is delivered through a slot along the full width of the sensitised surface of the paper.

The ammonia is supplied to the developing section from a Winchester enclosed in a recess at one end of the machine, the liquid being drawn by a constant-volume diaphragm pump and delivered to a feed glass. This feed glass incorporates a non-clogging valve which is adjusted to drip-feed the liquid in accordance with printing requirements. Excess liquid delivered by the pump to the feed glass is returned by a by-pass to the Winchester. The liquid for developing purposes is delivered into a long tray at the rear of the machine where it is vaporised by heaters. Above this tray there is a long shallow duct from which two fans draw off and pressurise the vapour to force it through a slot over the length of the sealed chamber through which the paper is carried by the rolls. The chamber is in a closed circuit with the fan duct, and in this assembly the vapour is constantly recirculated. It is stated this method of vapour recirculation reduces the amount of ammonia used to about a quarter of that required in machines using the perforated plate or roller method of ammonia developing at high speeds.

The large volume of filtered air required for cooling the machine is delivered by two motor-driven fans enclosed in a chamber at the rear of the machine. All of the controls are arranged on a panel along the top front of the machine, and the speed is controlled by turning a knob with reference to a speed-indicating arrow in a graduated slot. A roll carrier for the sensitised paper is fitted below the glass feed table, and a wire cutter facilitates separation when the required length has been used. Lamp changing has been made quick and easy by a new form of

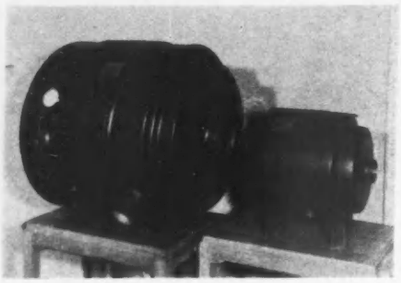


Synchronised combination printing and ammonia developing machine for producing prints at speeds up to 40ft per minute

mounting by which the lamp and its stainless steel reflector are withdrawn as a single unit from the revolving glass cylinder in the printing assembly. When required this glass cylinder can be easily cleaned by removing a panel along the front of the machine. The tension of the holding bands on the driven cylinders is released by the depression of a pedal bar at the front of the base.

Industrial Humidity Control

IN many branches of industry the presence of moisture in the atmosphere presents a serious problem, towards the solution of which greater use is being made of methods of humidity control. Among the varied problems which have been solved by dehumidification are included the prevention of corrosion of materials during storage; the processing and packaging of moisture sensitive tablets; the condensation on chocolates during chilling and the preservation of the insulation in electrical equipment. However, many applications require a relative humidity lower than that which can be achieved using conventional air-conditioning units, and for such applications the adsorption unit is of particular value. Cargocaire, Ltd., Friars House, New Broad Street, London, E.C.2, has recently introduced its "Rotaire" dehumidifier, of adsorption design, which operates on a new principle, but performs the same job as conventional units employing silica-gel or activated alumina. The principle involved and the method of construction results in a compact unit which, compared with a silica-gel dehumidifier, occupies about half the space, weighs about half and consumes about half the power.

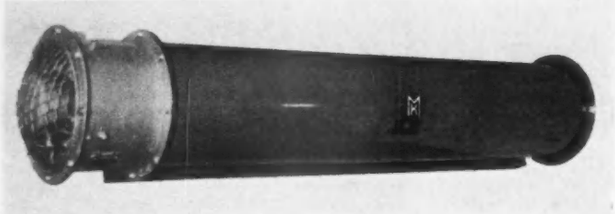


"Rotaire" dehumidifier models "M-600" and "M-75"

The absorption bed of the "Rotaire" unit is in the form of a drum filled with absorption material, having a honeycomb structure with the walls of the cells being impregnated with a hygroscopic substance. This form of structure makes the unit rapidly responsive to the moisture content of the air being circulated through the cells. The diameter of the drum and the depth of the filling are arranged in accordance with the rate of airflow and the degree of dryness required, and the drum rotates very slowly at a constant speed, of about 4 revolutions per hour between two fixed ducts. These are divided into two sections and into one of these adsorption air is passed and flows through the bed into the corresponding section of the duct on the other side, while a stream of hot air is fed into the other section on the adsorption outlet side and passes through the bed into the corresponding section on the adsorption inlet side. Thus the adsorption material passes successively through a sector in which it absorbs moisture from the air and then a regeneration sector in which hot air drives off the adsorbed moisture to atmosphere. A cooling sector is also provided in many models and allows a proportion of the regeneration air, before heating, to pass through the bed and thus remove some of the residual heat of the regeneration cycle to improve the efficiency of adsorption.

In the "Rotaire" dehumidifier the drying process is continuous and for a constant ambient condition and rate of regeneration heat input, the outlet air has a constant dry bulb temperature and specific humidity. Mention has been made already of the saving in space, weight and power which has been effected by the design and the following figures serve to demonstrate the advantages claimed over a conventional solid adsorbent dehumidifier. A "Rotaire" unit having an airflow of 4000 cubic feet per minute and a moisture removal capacity of 200 lb per hour, has a weight of 2·5 tons, occupies a floor area of 55 square feet, and requires 380 lb per hour of steam at 50 lb per square inch. The corresponding figures for a silica-gel unit are given as 5 tons, 90 square feet and 650 lb per hour at 100 lb per square inch respectively. Our illustration shows two "Rotaire" units; model M–600, which has a capacity of 350 cubic feet per minute, removes 4 lb per hour at 62 deg. Fah. entering dewpoint, using 1·8kW regeneration power. The smaller unit on the right, the M–75, has a capacity of 45 cubic feet per minute and removes 0·7 lb per hour at 62 deg. Fah. entering dewpoint, using 0·4kW regeneration power. Models in production range from 45 to 4000 cubic feet per minute capacity and designs for units up to 7000 cubic feet per minute have been completed.

An associate company, Minikay, Ltd., has introduced the "Miniveil" Mark IX air curtain unit, which has been designed to overcome the difficulties of limited headroom available over cold room doors. The illustration below shows a unit of the new design which can be made in uniform lengths and diameters to suit different sizes of doors, while, in addition, the capacity of the input fan can be varied. An axial flow fan is fitted in the unit illustrated, but centrifugal fans can be mounted if required. Operators of refrigerated accommodation have problems associated with the opening of doors, since, if the doors are open for any length of time, there is a danger of an unacceptable rise in temperature owing to the fall out of heavy cold air and the ingress of ambient air. This problem is met by the "Miniveil" air curtain, which projects a curtain of ambient air downwards over the opening at a velocity sufficient to contain the cold air in the cold space.

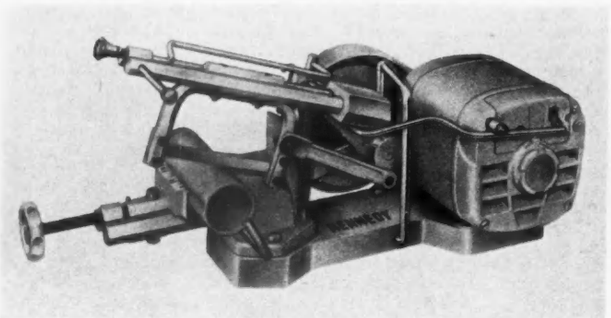


"Miniveil" air curtain

Portable Power Hacksaw

WE illustrate an improved model of the portable power hacksaw made by W. Kennedy, Ltd., Station Works, West Drayton, Middlesex. This machine is driven by a ⅓ h.p. electric motor and takes material up to 2⅜in diameter or 2in square in its vice. It weighs only 41 lb when fitted with a motor or 15 lb when arranged for a belt drive. An adjustable dash-pot relief mechanism is fitted, the saw pressure is controlled by a spring and the dash-pot, no weights being required.

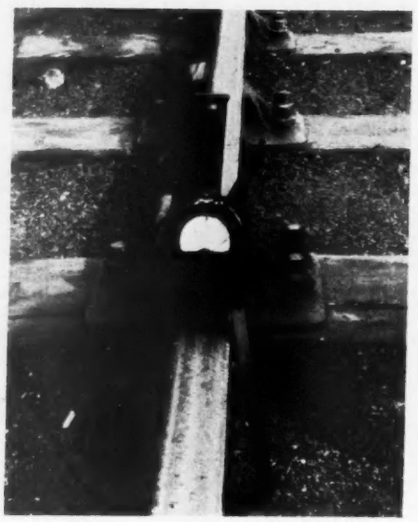
The saw frame accommodates any type of high speed blade up to ½in wide, including broken lengths of over 6in which are secured by simple Allen screw clamps. The vice jaw is calibrated in fractions of an inch to facilitate the cutting off of short lengths of material and a depth gauge and a length gauge are fitted to give consistent accuracy on repetition cutting work. The machine can be fitted on a bench, or if required, the makers can supply pedestal or tripod mountings.



Portable power hacksaw driven by a ⅓ h.p. motor and designed for cutting 2⅜in diameter bar

Clip-On Ammeter for Railway Electrification

A NEW ammeter based on the conventional Ferranti clip-on range has been introduced by Ferranti, Ltd., Hollinwood, Lancs, for measuring track current in railway a.c. electrification. The instrument, which is the first of its type to have been developed specifically for railway applications, operates on the split-core current transformer principle, but has a special triangular-shaped core so that all standard types of railway lines can be easily embraced. Six separate ranges are obtainable on the instrument, and are controlled by a thumb-operated selector switch. These are 0–10A, 25A, 50A, 100A 250A and 500A a.c. Accuracy is within 5 per cent of full scale on all ranges. In the illustration the meter is shown clipped on one of the running rails, which form the current return path in high-voltage a.c. electrification with overhead contact wire.



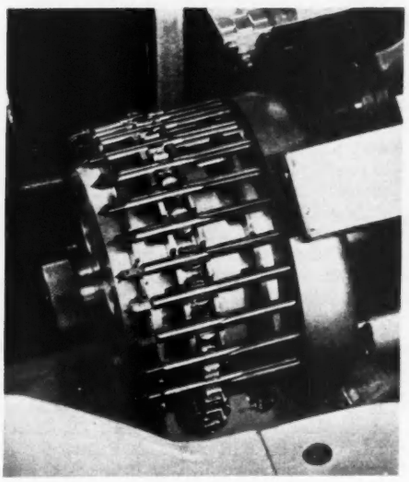
Measuring traction return current with ammeter clipped on rail

Automatic Tap Thread Grinding Machine

AN automatic thread grinding machine for small taps up to ½in diameter or similar components, which has been added to the Newall-Keighley range of machines, is now being marketed by Newall Group Sales, Ltd., Old Fletton, Peterborough. This machine, which

can be seen with the top cover removed in the accompanying illustration, is designed for a high rate of output with a completely automatic grinding cycle after initial setting. It is built for grinding a standard range of pitches from six to sixty threads per inch, and the machine can be set for right or left-hand helix up to 5 deg.

The wheelhead is mounted on vee and flat slideways and, when setting up, coarse infeed of the wheel is obtained by screw and nut, with a



Magazine feeder drum loaded with tap blanks; the indexing mechanism of this drum is interlocked with the machine grinding cycle

feed dial which is graduated direct to 0·00025in on work diameter. Wheel spindle lubricant temperature control is incorporated to ensure accurate sizing of the grinding wheel at all times. For wheel forming there are available a diamond dresser and a crusher, both of which are wheelhead mounted and arranged for manual control during setting-up operations. These formers have their control interlocked with the machine cycle.

A special sizing gauge is fitted to retain the grinding wheel in its original preset position. This unit positively compensates for wheel wear caused by grinding and also for removal of abrasive from the grinding wheel during dressing or crushing operations. With it gauging is carried out automatically at predetermined intervals when grinding is in progress and at the end of every wheel forming cycle.

The live centre workhead has a hollow spindle driven from a variable-speed d.c. motor at speeds ranging from 8 to 160 r.p.m. It is fitted with equipment for straight and for spiral flute relief grinding. A multi-pass turret built into the machine table permits two or three passes of the wheel to be made when it is required to grind taps to finished size. It is interlocked with the machine cycle.

The magazine feeder available with the machine, which is shown in our upper illustration, is electrically and pneumatically operated. It consists of a feeder mechanism, which is automatically interlocked with the machine cycle, and a drum magazine built in different capacities to accommodate particular sizes and types of taps. The drum holds the taps in spring clips and is arranged to feed each tap into the machine in such a way that correct relationship is established between the flute and the wheel for relief grinding.

The machine operating sequence is fully automatic and commences when the starter button is depressed. In the sequence the magazine is first fed towards the grinding centres and is moved by the pneumatically operated tailstock spindle towards the workhead.

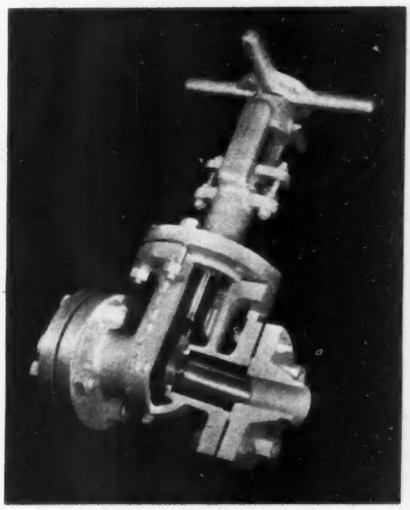
When the tap blank in line to be ground reaches the workhead, the square on the blank is located in the work driver and on the work spindle centre. On this position being reached the magazine withdraws, leaving the tap in the grinding position. The machine table then rocks forward, the blank rotates and traverses across the wheel. On completion of the grinding stroke the table withdraws and the tailstock centre retracts, allowing the finished tap to fall into the ejection chute. The work spindle is then automatically positioned in the correct rotational location in readiness to receive the next tap.

To complete the sequence of operations, the table is rapidly returned to its starting position and the magazine is automatically fed in and indexed to present the next blank in the loading position. When the magazine has been emptied of blanks visual and audible signals are given as the cycle stops.

Gate Valves

A GATE valve now being made by Joshua Hindle & Sons, Ltd., Neville Street, Leeds, is fitted with " Fluon " seals which, combined with the metal-to-metal fit of the wedge against the valve seats, provides a completely leakproof construction. The construction of one of these " Hindle-Hamer " valves can be seen in the photograph of a cut-away model which we reproduce.

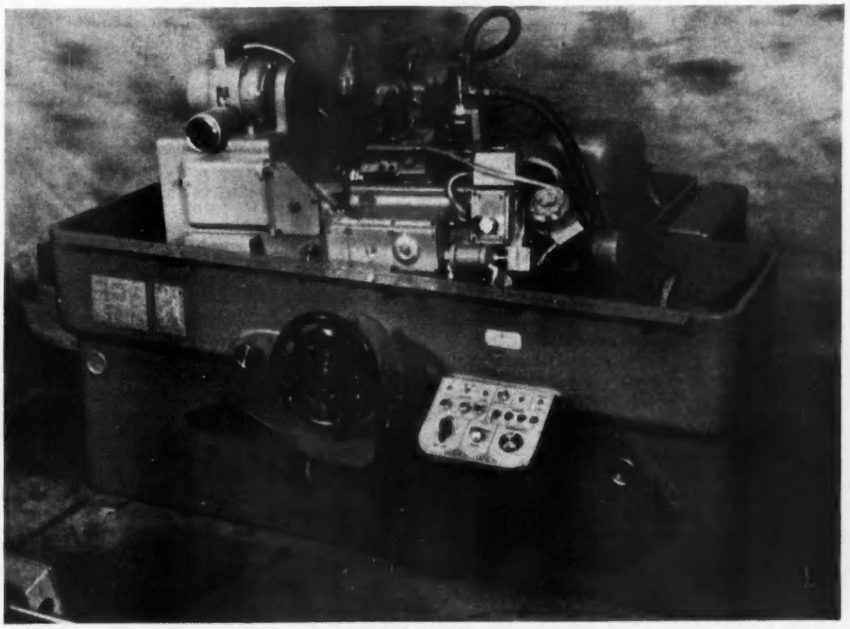
The two " Fluon " seals are contained by stainless steel sleeves which extend through the full bore of the valve and they are compressed by the wedge as it is screwed down. These rings absorb any alterations in the angular and



Gate valve with " Fluon " seals

distance relationships of the two seating faces which may be caused by line stresses and varying pressure and temperature conditions. To provide a check that the seal is effective when a valve is closed the bonnet is tapped and plugged for the installation of a tell-tale bleeder which gives visible proof that the valve seals positively on the upstream face. The effect of cumulative wear on wedge and seat surfaces is avoided owing to the properties of " Fluon," which is unaffected by most known chemicals and has plastic flow properties which enable the material to contain any solids likely to score metal seats.

These valves are available in carbon steel or stainless steel, the stainless steel models being made in sizes from ½in to 6in, and the carbon steel models in sizes from 2in to 16in.



Automatic thread grinding machine for taps up to ½in diameter, with covers removed

Northern Approach to Runcorn–Widnes Bridge

THE Minister of Transport and Civil Aviation has approved a scheme for the construction of a new road leading to the Runcorn–Widnes Bridge, which will cost more than £1,000,000. The proposed road will lead from the junction of the Liverpool, Manchester and St. Helen's roads to the immediate northern approach of the bridge. It is expected that work will start during the autumn. It is expected that 7500 vehicles per day will use the bridge.

The new link road will be three-quarters of a mile long. For a good part of the way it will be constructed on viaduct and there will be a flyover where it crosses Ditton Road, which is part of A.562, the Liverpool–Manchester route. Slip roads will connect the roundabout with A.562 and with the St. Helen's Road (A.568). At the southern end there will be slip road connections with Lower Church Street, which will be widened to its junction with Waterloo Road. There will also be connections with a large industrial estate lying between the main railway line and the River Mersey. The scheme has been designed by the county surveyor and bridgemaster of Lancashire, Mr. James Drake, M.I.C.E.

Industrial and Labour Notes

Co-ordinating Wage Claims

In the concluding stages of the House of Commons debate on the Budget proposals, on Monday evening, Mr. Robert Carr spoke about the "vexed, difficult question of wages." In some industries, he said, the wage structures were out of date, complicated and frustrating and ought to be changed. In other industries he felt that there would be a greater chance of a more sensible and more peaceful settlement of wage negotiations if the field of negotiation affected smaller and more distinct sections of industry. The "great, amorphous engineering industry," Mr. Carr continued, was perhaps the prime example of what he had in mind. Employers, he urged, should develop a habit of consulting together much more regularly than some of them did with the trade unions at what might be called the "close seasons" and not only when a wage dispute was in process. He thought that those industries in which that occurred found it easier to settle their wage claims in a sensible, intelligent manner. When it came to the individual employer in his individual factory, Mr. Carr added, the wider use of scientifically calculated incentives would help to provide workers with the earnings which they naturally felt they wanted and needed, without, at the same time, putting up the labour costs of production.

Mr. Carr went on to make some suggestions as to what the trade unions might do. There were, he thought, two main courses of action. First, in some industries it must be accepted that there was an out-dated union structure and a rigid demarcation, both in and between crafts, which caused stoppages, made wage negotiations difficult and prevented the individual worker from having the best chance to earn a high wage and to adapt himself to technological changes. Only the trade unions, Mr. Carr remarked, could set about solving those problems; they were nothing to be ashamed of for they had grown out of age and out of the technological changes in industry. Secondly, Mr. Carr went on, if there was not to be a state wages policy, he believed that the Trades Union Congress must be given very real, though voluntary, powers of co-ordination over wage claims in the next year or two. If those things were done, Mr. Carr argued, there was hope of fewer disputes and of wage settlements more in tune with economic needs, with greater satisfaction to individual workers.

Federation of British Industries

The annual general meeting of the Federation of British Industries was held in London on Wednesday of last week. At it, Mr. W. H. McFadzean, chairman and managing director of British Insulated Callender's Cables, Ltd., was elected president in succession to Sir Hugh Beaver, who has held the office for two years.

In an address at the meeting, Sir Hugh Beaver emphasised the need to keep British industry competitive and efficient. He pointed out that 76 per cent, or more, of all the people "gainfully occupied" in this country were in industry or commerce; 4 per cent were in agriculture. He added that this country exported about 40 per cent of its production and that, though it could claim only about 8 per cent of the total world manufactured production, it was still not far short of holding one-fifth of the published figures for world exports. These facts, Sir Hugh said, were a mark of this country's industrial greatness and of its achievement in the face of ever-increasing competition. He went on to suggest that in the world to-day and perhaps particularly in a country such as Britain, completely unable to support itself out of its own natural resources, the Government—every and any Government—must play a considerable part in industrial affairs. There must be, to a large degree, overall planning; it was not sufficient for the various parts of industry to be efficient, Sir Hugh remarked, industry must be, and must be able to be, an efficient and effective machine as a whole.

Everything, Sir Hugh continued, pointed to a closely knit alliance between this country's free-enterprise competitive industry, on the one hand, and the Government on the other; by that, Sir Hugh explained, he meant the whole machinery of Government, and governments of whatever complexion. He went on to express the view that industry must accept that this was a "joint exercise" and that there was nothing now to be said for the old Victorian freedom of action even if that were still practicable. It was a corollary, Sir Hugh observed, that the first and overriding consideration of the Government must be the creation of the conditions in which British industry could be efficient and competitive; more efficient and more effective than the industries of those countries with which it had to compete.

British Steel

The British Iron and Steel Federation has prepared a pamphlet, entitled *Steel: Fact and Fiction*, which presents very lucidly the steel industry's case against nationalisation. Concurrently with this pamphlet, the Federation has issued its quarterly bulletin *Steel Review*, in which is published an article entitled "Facts about Steel Development." This article, the Federation explains, "examines inaccurate and misleading statements recently published about the steel industry and, in particular, about its development.

In surveying the three development plans upon the fulfilment of which the industry has been continuously engaged since the war, the article emphasises that "there is no basis for the suggestion recently made that the steel industry has not planned to provide an adequate margin of capacity." The targets, in the case of each of the three plans, were agreed by the body responsible for the public supervision of the industry after consultation between the government departments concerned and the industry itself. "In no case," it is observed, "has any Government suggested that the target so fixed should be higher."

The article goes on to point out that the steel industry's post-war development programme has been carried out under a system, the essential elements of which are the individual initiative and commercial judgment of the companies engaged in the manufacture of a diverse range of products, combined with central pooling of information about development and public supervision exercised by an independent Government-appointed authority. The period of effective state ownership and control was too brief to have any significant or lasting influence. Under the system described, the Federation adds, the responsibility for initiating and carrying out development rests with the 308 companies, of which 295 are privately owned. The article comments also on the erroneous statements which have been made about the ownership and control of the steel industry, mainly because the Iron and Steel Holding and Realisation Agency retains a "certain stake." Companies producing 88 per cent of crude steel output have now been denationalised, and even taking into account the Agency's total holding at its nominal value, it covers less than a third of the net assets as shown in the latest available balance sheets of all the companies once nationalised. It is also obvious that, but for the threat of renationalisation on terms which are undefined, but which, if previous experience is taken as a guide, would bear little relation to the real value of the assets, an even greater proportion of the capital vested in the Agency in 1953 would by now have been sold back to private investors. This threat, the Federation adds, is also impeding the raising of new capital for development in the open market. But, despite the difficulties caused by the political uncertainty, and although there has been a sharp temporary setback in the growth of demand for steel, the British iron and steel industry has continued to expand its expenditure on development. Last year, a record amount of £105 million was spent and this level of expenditure is to be maintained during the current year.

F.B.I. Overseas Scholars

The President of the Board of Trade, Sir David Eccles, was the principal guest at the fifth annual dinner of the Federation of British Industries overseas scholars, which was held in London on Tuesday evening. Mr. W. H. McFadzean, president of the F.B.I., was in the chair. Acknowledging a toast to the guests, Sir David Eccles urged the students from overseas to keep in mind the need to help their respective countries to become great. Many of them, he said, were representatives of countries still in their infancy, but which were "coming along." In the present age, Sir David added, it was not just the numbers of population that counted; it was the number of qualified engineers and scientists which was of the first importance. All the students, he felt certain, looked forward to returning to their countries to become important engineers; there was opportunity for them to join together in the great enterprise of keeping the free world expanding.

It was stated at the dinner that since the scheme started 282 scholars had come to Britain from Commonwealth and Latin American countries and from the Middle and Far East. In addition, eleven young engineering professors (ten from Latin-America and one from Ethiopia) had come to this country under the joint F.B.I.-British Council scholarship scheme for combined academic and practical training.

Low Friction Valve Control

A GREAT reduction in friction between the nut and thread of a screw spindle transmission can be achieved, it is claimed, by the use of the "Roulement Hélicoïdal" system invented by Monsieur Carl Bruno Strandgren, Ets Volvis, Ecublens (Vaud), Switzerland, and made in France under licence by La Technique Intégrale, 18bis, Rue d'Anjou, Paris (8^{e}). This design comprises three main components: a screw spindle; a nut with the same thread cut into it but of larger bore diameter, and an intermediate cage holding a number of threaded rollers which are interposed between the nut and the spindle. The screw profile of these rollers is triangular and slightly truncated, with curved flanks (Fig. 1),

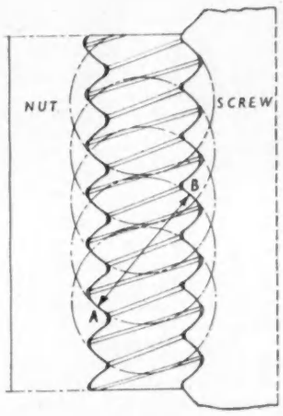


Fig. 1—Principle of "Roulement Helicoïdal" screw and nut movement. Between the screw and nut are interposed longitudinal rollers with threads cut to the same pitch. The flanks form part of spherical surfaces as shown by the chain-dotted lines. Each pair of contacts, such as *A* and *B*, lies at opposite ends of a diameter of one of these imaginary spheres which mutually interpenetrate. In this way, sliding friction is replaced by rolling friction

the radius of curvature being that of an imaginary sphere placed between nut and spindle. Contact occurs at points corresponding to opposite ends of diameters of these spheres, such as *A* and *B* in the illustration. In this way, a rolling motion is substituted for the sliding motion of an ordinary screw and nut combination, and the efficiency is stated to reach values as high as 90 per cent.

"Roulement Hélicoïdal" movements have been built for axial thrusts ranging from 50 kg to 100 tonnes and for speeds of from 2 to 3000 r.p.m. Screw spindles may, of course, be made in any length required by a specific application, and in fact sizes have varied so far between 25mm and 5000mm. The principle has been used in connection with aircraft controls, machine tools, radar aerials, special purpose machinery and others.

One important recent application is to the control of hydraulic valves. Thus, the Société des Forges et Ateliers du Creusot (Usines Schneider) has supplied a set of butterfly valves incorporating this device, for the Kemer Barrage in Turkey, which was built by the Compagnie Française d'Entreprise on behalf of the owner, E.M.C.-R.A.R. This important scheme is situated in the Aegean coastal region and is designed to provide flood control on the river Akçay and water regulation in the Büyük Menderes valley. It provides irrigation for an area of several tens of thousands of hectares as well as an electric output of 143 million kWh in the mean year. The Kemer dam is a gravity dam 116m high. From a catchment area of 3240 square kilometres it impounds a water volume of 640 cubic kilometres, of which 520 cubic kilometres can be utilised. The dam has a concrete volume of 790,000 cubic metres and the power station contains three turbine sets each of 23kVA.

The two valves are situated one in each of the two pressure penstocks which serve to drain the dam and for irrigation at the point where the penstocks pass through the concrete. The water is controlled by "hollow jet" valves (also supplied by S.F.A.C.) and the butterfly valves are placed upstream to act as guard valves.

Each has an internal diameter of 1900mm and works under a static head of 100m. They are carried out as steel castings, with cast steel butterfly discs in two halves, assembled on a vertical, square, forged steel arbour to which an operating arm is attached. The latter carries at its end the "Roulement Hélicoïdal" nut, as shown in our second illustration, Fig. 2. A geared-down electric drive is used to operate the screw spindle, and in emergencies a handwheel can be brought into engagement to turn the spindle manually. It may be mentioned here that the valve disc is equipped with a special metallic jointing which can be adjusted from downstream without the necessity of dismantling the valve.

The spindle of the "Roulement Hélicoïdal" is subjected to compressive forces of up to 38,000 kg and tensions of 22,000 kg. It is turned at a rate of 19·5 r.p.m. by a 9 h.p. motor. About five minutes are required for full opening or closing.

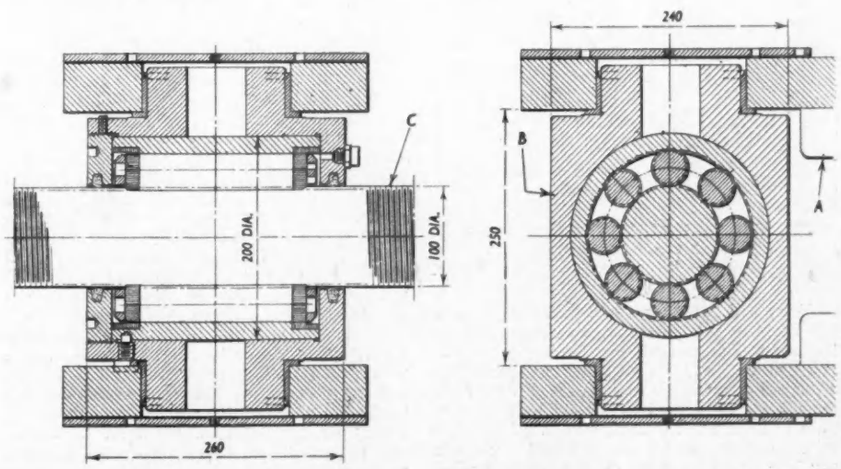


Fig. 2—Sections through end of valve control arm (*A*), carrying low friction nut assembly (*B*) which operates in conjunction with control spindle (*C*)

August Thyssen-Hütte Annual Report

In its annual report for the year ended September 30, 1958, published on March 24, August Thyssen-Hütte Aktiengesellschaft, Duisburg-Hamborn, states that production at August Thyssen-Hütte during the year in question amounted to 1,270,000 tonnes of coke, 1,640,000 tonnes of pig iron, 2,040,000 tonnes of crude steel, and 1,630,000 tonnes of rolled steel. Gross turnover was DM.974 million (1956–57, DM.838 million). For the steel production of just over 2,000,000 tonnes, the plant consumed 1,570,000 tonnes of coke and coal, 4,050,000 tonnes of ore and other iron-containing material, 400,000 tonnes lime and limestone, and 550,000 tonnes of scrap; this represents 3·2 tonnes of raw materials per tonne of steel produced. The number of employees at the end of the year amounted to nearly 11,200 (10,700) of whom nearly 1600 (1400) were salaried staff.

August Thyssen-Hütte, Niederrheinische Hütte and Deutsche Edelstahlwerke together produced 2,740,000 tonnes of steel and had an external gross turnover of DM.1776 (1722) million. Total employees on September 30 numbered 33,400 (32,500). On the nominal capital of DM.310 (290) million, a dividend of 9 per cent (9 per cent) was declared.

In spite of substantially increased competition, the results are regarded as satisfactory, although the rate of growth has slowed down. For the first time since the re-founding of the company its rapid development has been interrupted. Since February, 1958, steel output had been below production capacity, and production in the second half of the year fell off by 18 per cent, while turnover decreased by 11 per cent. The combined steel production of the three plants, 2,700,000 tonnes, represented 11·5 per cent of the total produced in the Federal Republic.

The report states that as a final measure of re-organisation, August Thyssen-Hütte A.G. intends to take over, against an issue of new ATH shares, the majority holding in Phoenix-Rheinröhr A.G. Vereinigte Hütten-und Röhren Werke which at present is in the possession of the holding company Fritz Thyssen Vermögensverwaltung A.G., a major shareholder in August Thyssen-Hütte A.G. In order to carry out this measure, an increase of the issued capital of DM.80,000,000 is to be made. The proposed measure will, it is stated, give the Thyssen group increased powers of resistance against market fluctuations, new possibilities for rationalisation and cost reduction, and increased ability to compete. It would not involve substantial changes in the way the market for the various rolled products is being shared among the constituent works, and would not constitute a penetration by the group into fields of production which follow on the production of iron and steel. The production ranges of ATH and Phoenix-Rheinröhr did not overlap but were supplementary and their combination would result in a rounding-off which was of particular importance to the works in the Thyssen group. The proposal is subject to agreement of the High Authority of the European Coal and Steel Community, to whom an application has been submitted. In 1957–58, the Thyssen group produced a total of 5,100,000 tonnes of crude steel, equivalent to 8·6 per cent of the Community's total steel output.

Ludwig Prandtl Memorial Lecture

The Wissenschaftliche Gesellschaft für Luftfahrt (WGL), Brunswick, and the Gesellschaft für Angewandte Mathematik und Mechanik (GAMM), Munich, decided in 1956 to hold an annual memorial lecture in honour of Ludwig Prandtl, the pioneer aerodynamicist. This year's meeting is being held within the framework of the Annual Meeting of GAMM in Hanover. On Thursday, May 21, at 5.30 p.m., Monsieur Maurice Roy, Director-General of O.N.E.R.A., will speak about "The Formation of Vortex Zones in Low Viscosity Flow." Persons interested in the lecture should contact the WGL Western Secretariat, Cologne, Ebertplatz 2 V.

Double Cantilever Bridge over the Carquinez Strait in California

BY OUR AMERICAN EDITOR

No. I

With the opening to traffic on November 28, 1958, of a second highway bridge across the Carquinez Strait between Crockett and Vallejo, California, a critical road bottleneck was broken. The original bridge now carries three traffic lanes southbound towards San Francisco, and the new bridge carries four lanes northbound towards Sacramento. The main double cantilever bridge structure is 3350ft long and is supported on three caisson piers, one cofferdam pier and an anchorage pier. The design and construction of this bridge are of particular interest because of the extensive use of welded fabrication and high-strength steel bolting instead of riveting. Furthermore, the bridge superstructure constitutes the first application of the new "T-1" high yield strength structural steel of the United States Steel Corporation.

THE Carquinez Strait is an arm of the San Francisco Bay which lies directly in the path of the natural highway connecting the bay area with the Sacramento Valley. The Carquinez Strait is a navigable body of water approximately 3000ft to 5000ft wide with velocities varying from 5ft to 10ft per second, and since the early gold rush days of California has been a formidable barrier to the development of land transport. The first attempt to overcome this barrier was in 1850 when a ferry was established to cross Carquinez Strait between Benicia and Martinez. In 1879 the Central Pacific Railway succeeded in establishing railway transport across the strait by building two large ferries for the transport of trains across the strait. Ferry service thus remained the only facility for land transport until the 1920s when the American Toll Bridge Company started the construction of two highway bridges, one known as the Carquinez Bridge situated at Crockett and the other situated about 15 miles upstream, called the Antioch Bridge. At about the same time the Southern Pacific Company started the construction of a railway bridge across the strait between Benicia and Martinez, about 6 miles upstream from the Carquinez Bridge. These three bridges have, therefore, been the sole means of land transport across the Carquinez Strait for the past thirty years.

In spite of the tremendous increase in highway traffic over the past thirty years, no increase in highway transport facilities has been made. In the five years after the end of World War II, highway traffic across the Carquinez Bridge more than doubled until it reached an annual traffic count of over 10,000,000 cars per year. The three-lane roadway of the existing bridge, therefore, became a very serious bottleneck to the natural development and free flow of highway transport between San Francisco and the Sacramento Valley. Since the end of World War II it became apparent that some means of financing additional highway facilities across the strait would have to be found. Because of the large amount of funds needed and because it would require a large concentration of state petrol tax expenditures in two relatively small counties of the State of California over a short period of time, this kind of financing seemed impracticable.

Accordingly the California Legislature in the summer of 1955 passed legislation making it possible for the California Toll Bridge Authority to build two new bridges across Carquinez Strait to be financed by the sale of revenue bonds not to exceed 80,000,000 dollars. The first of these is the structure parallel to, and about 200ft upstream from, the existing Carquinez Bridge on U.S. Highway 40, and the second is a bridge about 6 miles upstream, between the cities of Benicia and Martinez on State Route 75. Since plans for the first Carquinez span had already been prepared, it was possible to advertise for bids on this part of the project in October, 1955. Bonds in the amount of 46,000,000 dollars were sold in December, 1955, and construction officially started the same month. The major contracts on the project were as follows: (1) Work on 2·9 miles of approach road to the south of the bridge, awarded to the joint venture of Ferry and Crow for about 7,200,000 dollars. (2) The Crockett Interchange structure joining the main bridge and the freeway contract, awarded to Peter Kiewit Sons' Company for 4,700,000 dollars. (3) Foundation work for the main bridge, awarded to Mason and Hanger, Silas Mason, Incorporated, and F. S. Rolandi, Jnr., Incorporated, for about 5,500,000 dollars. (4) The superstructure of the main bridge, awarded to the United States Steel Corporation, American Bridge Division, for about 9,500,000 dollars. (5) Road work for a 1·2 mile stretch at the north end of the bridge, awarded to the Fredrickson and Watson Construction Company–Ransome Company for approximately 1,800,000 dollars. (6) Construction of the Administration Building and Toll Plaza, awarded to the W. J. Kubon Company for about 500,000 dollars.

Fig. 1—Map of Carquinez bridge site

The Big Cut

The 7,200,000 dollar contract for the approach freeway to the south of the bridge contained one of the largest cuts in the history of highway building in California, and possibly in the United States. Called the "Big Cut," this excavation had a width across the top of 1370ft and varied from 245ft deep at the centre line to 350ft deep when measured from the highest point on the cut. It contained 9,700,000 cubic yards, a large percentage of the 11,200,000 cubic yards in the total contract.

This cut was decided on after study of other possible lines and after the consideration of an alternative tunnel design. Considering first cost, maintenance, right-of-way, highway user costs, convenience, safety and disturbance to existing property, the line chosen appeared to have the advantage over all others. Comparing a cut section to a tunnel, there were two factors that made the cut a decidedly more satisfactory solution—first cost and safety from earthquakes. Since the tunnel would pass through a faulted, unstable area, its lining would have to be heavy and costly to construct, and throughout its life it would be subject to considerable danger from earth movement. Preliminary borings indicated that an older Cretaceous sandstone and sandy shale had been thrust over younger Eocene shale, mixed with a steeply upturned Miocene stratum consisting of interbedded shale and hard sandstone. Water was also found in sufficient quantities to make subdrainage an important problem in the design of the cut.

Based on the findings from the borings and the studies of general terrain and earthquake conditions, the following design for the cut section was chosen. Slopes were set at 2 : 1 with 30ft benches every 60ft of elevation. At grade the cut provides for two 36ft paved roadways, with provision for two additional 12ft lanes, 9½ft outer shoulders, and 2ft shoulders adjacent to the 4ft raised median strip, making the cut 200ft wide at the bottom. To drain the trapped underground water, which was found in aggravating quantities, horizontal perforated casings of 2in diameter were drilled laterally into the cut slopes. About 24,000ft of these drains were

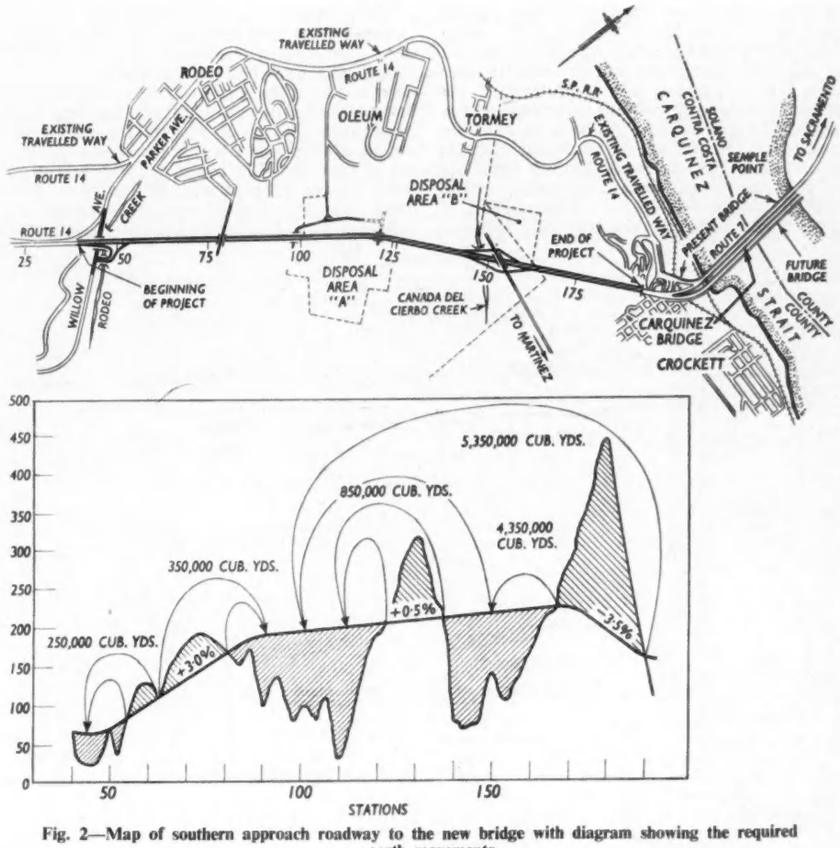


Fig. 2—Map of southern approach roadway to the new bridge with diagram showing the required earth movements

required to provide adequately for the sub-drainage and structural stability of the cut section.

The " Big Cut " yielded about 2,400,000 cubic yards of material in excess of that needed for roadway fills. This material was placed in disposal area " A," shown in Fig. 2, to improve the property of the Union Oil Company in return for the right-of-way which this company provided for road construction. The shale and sandstone encountered by the contractor during excavation varied in hardness. It was found possible to excavate by ripping at all locations except the cut at about Sta. 130, which is the first cut to the south of the " Big Cut." Here it was necessary to shoot and excavate with a 2½ cubic yard shovel and use 8 cubic yard dump trucks for disposal.

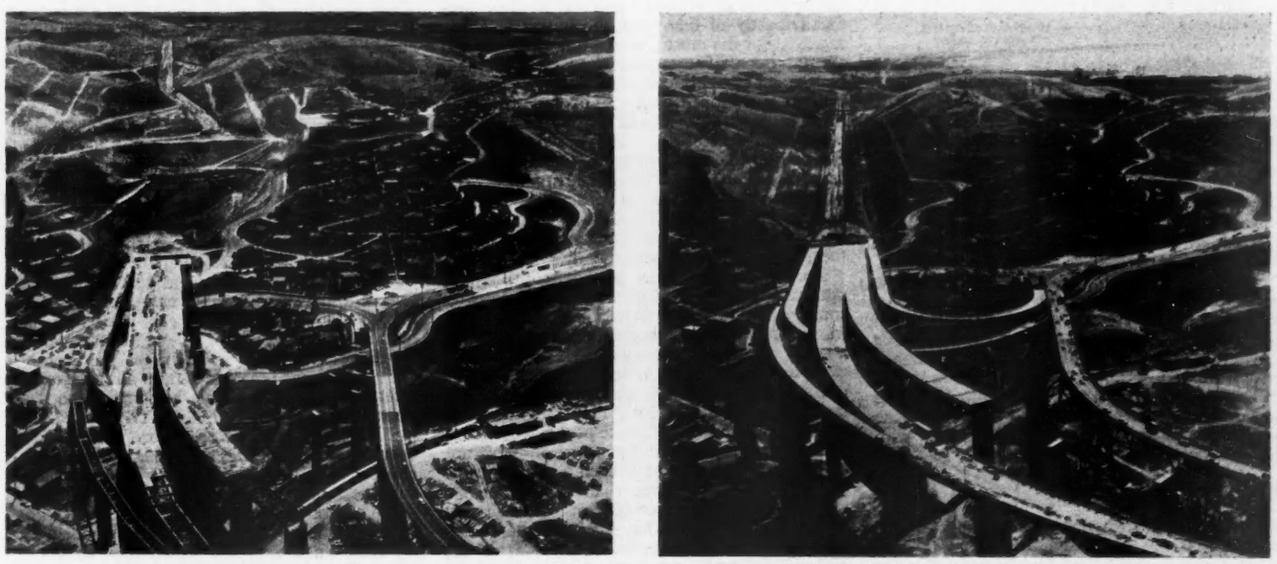
The contractors elected to use tractors coupled with scrapers hooked in tandem to move the majority of the dirt. This was possible because of the favourable −0·5 per cent grade on the long haul. The average haul from the " Big Cut " was about 8000ft. Each unit was capable of making about four round trips an hour, moving an average of 37 cubic yards per trip. The contractor's schedule called for moving an average of 25,000 cubic yards per day ; his actual average for the entire project was approximately 26,000 cubic yards per 14-hour working day. The standard equipment for push loading and ripping was a tractor equipped with ripper teeth. The use of this equipment eliminated all blasting in the " Big Cut " with the exception of the minor cracking of huge boulders. Many nests of these boulders averaging 8ft to 10ft in diameter were encountered at different elevations throughout the cut. They were pushed into piles, drilled and broken with powder to a small enough size for loading. They were then hauled to and incorporated in the fills.

The " Big Cut " was nearly 10 per cent complete before the heavy rains in the winter of 1957–58. Considering the fact these were the heaviest recorded rains in eighty years, the slopes stood up remarkably well. Only one slide occurred, amounting to approximately 100,000 cubic yards. This took place at the top bench elevation and was approximately 60ft deep. Unfortunately it occurred in the only developed area bordering the cut and resulted in the removal of four homes. The remainder of the cut showed little signs of distress and only minor surface sloughing occurred.

Crockett Interchange

The Crockett Interchange serves as a connecting viaduct between the " Big Cut " and the south end of the main bridge. It also acts as an interchange structure for the town of Crockett. This structure is of conventional steel-girder design, with span lengths varying from 120ft to 180ft. The girders are supported on forty-seven reinforced concrete piers which vary in plan from a solid shaft 6ft by 22ft to a boxed shaft 20ft by 76ft, and in height from 20ft to 123·5ft, the average height being close to 70ft. The piers were all designed without batter or offsets so that slip-form construction could be used by the contractor if he so desired. The Peter Kiewit Son's Company investigated this method and decided to adopt it, using slip-forms developed by B. M. Heede, Incorporated. Slip-forms have been used before in the United States but they have been of the manually operated screw-jack design. This type is cumbersome to keep level, and troublesome to keep moving at a constant rate at all points.

The development of an automatic controller for operating a series of hydraulic ratchet jacks has greatly simplified slip-form procedure. These jacks, situated about 7ft apart, are supported by, and climb up, high-strength steel rods of 1in diameter which extend down into the concrete. Each rod passes through a metal sleeve 3ft long which prevents the rod from becoming bonded to the green concrete. After the last pour on the pier, the rods are salvaged and the holes filled with grout. At the start of each pier, after the reinforcing steel, jack-supporting rods, and forms have been carefully set on the footing, the 4ft deep form is filled in layers of about



Figs. 3 and 4—Progress of construction at the " Big Cut " excavation for the southern approach to the bridge (left) February, 1957 ; (right) March, 1958

8in. As soon as the concrete has set sufficiently, which may be in about three hours, the jacking operation is started. Once jacking is under way, the form is "slipped" up at the rate of 5in to 14in per hour. The rate of rise is dependent on the rate of curing, which changes with the ambient temperature and wind velocity. An experienced operator determines the pace at which the form moves upward by pushing a thin steel rod down into the green concrete.

When the concrete below is exposed as the form rises, its surface is finished by trowelling. This is done quickly and easily. Occasionally small pockets caused by rocks gouging the slides during slipping must be filled and finished. To facilitate this part of the work, a finishers' platform is hung below the form on the outside of the pier and also inside if the pier is hollow. Very little finishing inside was necessary, however. This platform moves up automatically as the form rises.

For curing, a water pipe fitted with fog nozzles is hung below the finishers' platform. This keeps the exposed concrete constantly moist and provides excellent curing conditions even during hot, windy weather. Pouring is carried on continuously twenty-four hours a day, which, at the average rate of 10in per hour, provides a progress of about 20ft per day. On piers over 100ft high, which cannot be completed in a five-day week, operations are shut down over the week-end and an operator is left in charge to keep the form moving the very small amount sufficient to prevent bond until the slip-form comes to within 6in to 12in of the top of the concrete.

To check the piers for verticality, three targets are placed on each end and at the centre of one side. One target is placed near the bottom of the pier, one on the slip-form, and one on the reinforcing-steel template above the form. Water columns in transparent plastic tubes, situated at strategic points on the form, are also used to check for possible listing. As soon as a small deviation is noted, corrective measures are started by hand jacking at the low points. Corrections must be made gradually.

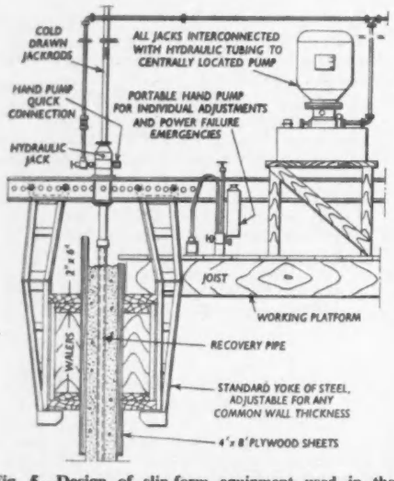

COLD DRAWN JACKRODS
ALL JACKS INTERCONNECTED WITH HYDRAULIC TUBING TO CENTRALLY LOCATED PUMP
HAND PUMP QUICK CONNECTION
PORTABLE HAND PUMP FOR INDIVIDUAL ADJUSTMENTS AND POWER FAILURE EMERGENCIES
HYDRAULIC JACK
JOIST
WORKING PLATFORM
WALERS
RECOVERY PIPE
STANDARD YOKE OF STEEL, ADJUSTABLE FOR ANY COMMON WALL THICKNESS
4' x 8' PLYWOOD SHEETS

Fig. 5—Design of slip-form equipment used in the construction of forty-seven bridge approach piers

The Crockett approach structure involved the welding of over 8,500,000 lb of structural steel for the girder spans. These spans ranged in length from 120ft to 205ft. The larger spans were made up of 144in by ¼in web plates with 24in flange plates top and bottom. The flange plates varied in thickness from 2½in at the centre to 1in at the ends. Field splices were made by welding the heavy flanges and bolting the web plates with high-strength bolts.

Bridge Substructure

Substructure work on the Carquinez Bridge involved the construction of an anchorage abutment set in a shale and sandstone cliff at the north end of the bridge to support one end of the 500ft north anchor truss span; three caisson piers founded on bedrock about 132ft below water level; one cofferdam-type pier supported on 240 steel bearing piles, and an anchorage pier 125ft high situated at the south end of the bridge. All three of the deep-water caissons are identical in design, being 53ft wide by 102ft 6in long. The caissons are of reinforced concrete construction with outer walls 3ft thick and inner walls 2ft 6in thick. When completed, the piers reached a height of 149ft. Each caisson is divided into eighteen dredging wells approximately 14ft square. The four corners of the caisson are rounded on a 12ft radius to reduce the pressures from high-velocity currents during the sinking operations.

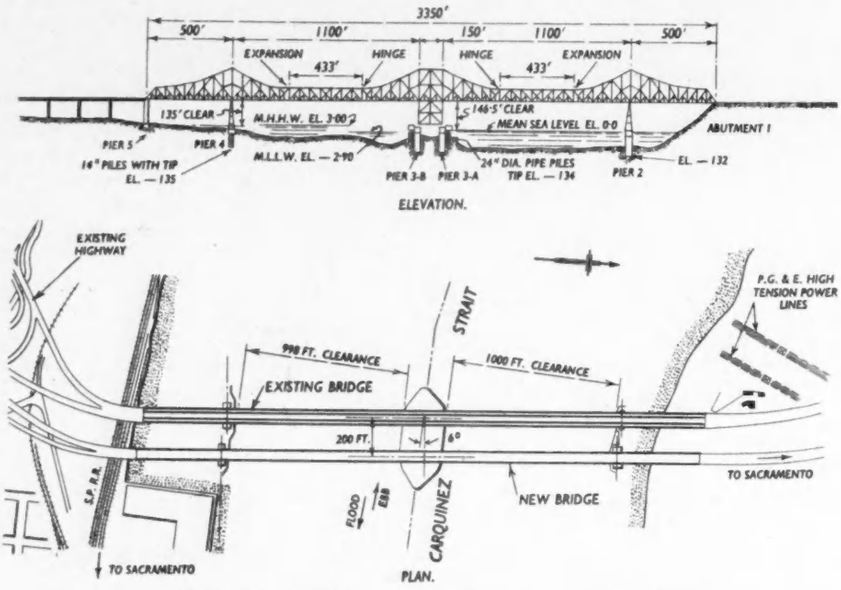


Fig. 6—Elevation and plan of new bridge over the Carquinez Strait

The contractor sank the caissons by means of jets, air lift pumps and clamshell dredging. The eighteen dredging wells of each caisson were sealed at the bottom with arched laminated timbers. Through each of the timber "false bottoms" a 30in diameter capped steel pipe was placed through which could be lowered a 6in diameter jet pipe and a 10in diameter air lift pump. After predredging in the area of the piers to about elevation −100.00, there remained approximately 35ft of overburden through which each pier was lowered. This overburden consisted mostly of fine sand and gravel and was removed for the most part by use of the jets and air lift pumps. The jets and pumps were operated from the four centre cells only; however, all the cells were equipped with the 30in capped pipes through which the jets and air lift pumps could be lowered if necessary. The jets loosened and churned up the sand and gravel, permitting it to be pumped out by the 10in air lift pumps. The jets were raised or lowered vertically by a work derrick. Rotation of the jets was controlled by levers operated manually and the movement of the nozzle was controlled manually by cables.

The bedrock at the bottom consisted of upturned layers of shale and sandstone with considerable variation in hardness. Pier No. 2 was situated close to the north bank which forms a steep cliff with the layers of shale and sandstone exposed on the side wall of the cliff. The nearness of this pier to the steep slope of the bedrock rising up to form the cliff provided very strong evidence that the plane of the bedrock on which Pier No. 2 was to rest would probably not be level. The caisson did reach bedrock on the cliff side about 3ft higher than bedrock on the opposite side. The specifications required that the pier must not be out of plumb more than 1 in 100. It was therefore necessary that the high side of the caisson cutting edge be lowered through the bedrock about 3ft.

The contractor chose to use blasting methods to break away the rock under the north cutting edge. Because of the depth of water, about forty-five minutes was the maximum time for a diver to stay at the bottom. For this reason, the contractor discarded the idea of drilling and blasting in favour of shaped charges. The shaped charges could all be placed during one trip of the diver. The contractor was aware that one of the big problems in connection with underwater blasting was to design the charge of sufficient size to fracture the rock without causing any damage to the caisson walls or steel facing for the cutting edges.

The contractor found that there was very little published information on the forces exerted by blasting within a closed caisson at various distances away from the charge. The caisson was designed for rather heavy forces directed from the outside toward the inside, but was not heavily reinforced for forces and impacts directed from the inside out. The contractor prepared a table showing the maximum safe charge plotted against the distance from the caisson walls. This table was prepared from information secured in the book *The Effects of Atomic Weapons*, prepared by the Los Alamos Scientific Laboratory.

On the basis of the available literature and discussions with various authorities in the high-explosive field, it appears that the science of underwater explosives has not yet been advanced to the point where accurate predictions as to forces exerted can be made. It is known that there is a certain amount of energy released with any particular blast, which can be determined with reasonable accuracy. The energy released is absorbed by: (1) breaking up the foundation bedrock, which is the sole purpose of the blast; (2) by raising the temperature of the water and rock; (3) by raising the elevation of the water surface, and (4) by distorting or rupturing the caisson walls. The ideal condition would therefore be to have nearly all the energy of each blast absorbed by breaking up or shattering the foundation bedrock, with little or none remaining for distortion or damage to the walls.

This approach indicates the advantage and safety of using drilled hole blasting methods as opposed to shaped charges. The drilled-hole method can be counted on to absorb most of the energy released by shattering the bedrock foundations. The shaped charges, on the other hand, will release a much greater part of their energies for distortion or even rupture of the caisson walls. The Carquinez Bridge caissons were divided into six cells lengthwise, and three cells crosswise. The 102ft 6in north side of the caisson was lowered through about 3ft of bedrock to make it

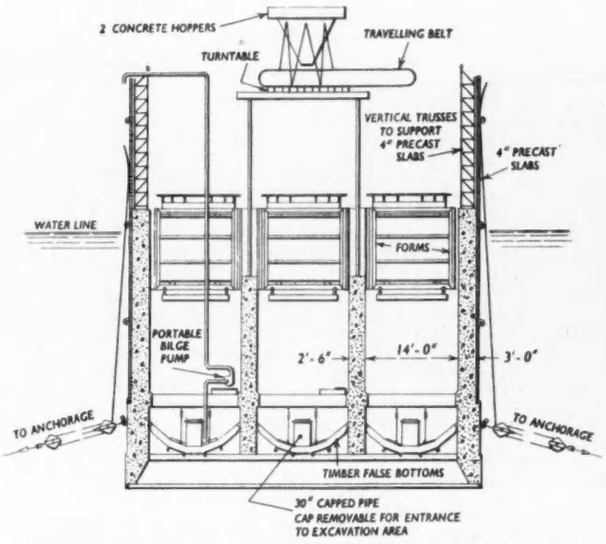


Fig. 7—Design of cutting edge used in the sinking of the three caisson piers to bedrock

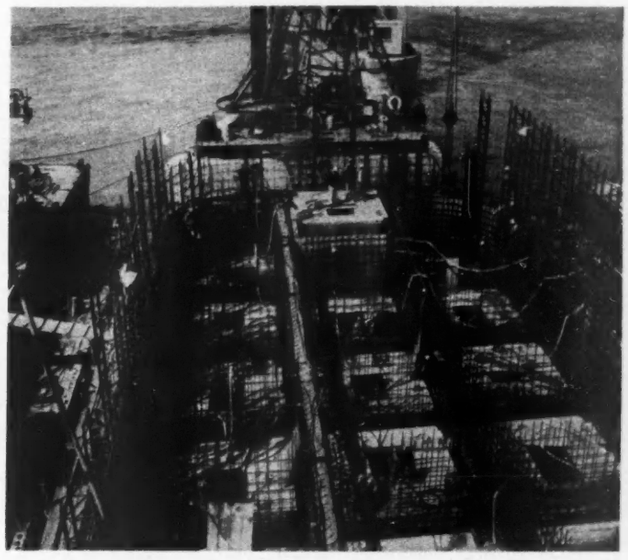


Fig. 8—Concreting work on one of the deepwater caisson piers

level with the south side. The shaped charges used were spaced on about 7ft centres along the wall and back from the wall about 4ft.

The shaped charges consisted of about 6 lb to 7 lb of explosive gelatine. The explosive charge was shaped by a sheet metal cone placed in the bottom of a 6in steel pipe. The explosive wave of the shaped charge formed a direct jet that concentrated its force on the rock below. Short legs held the entire assembly up about 6in from the rock to obtain a better effect. The average crater made by each blast was approximately 4ft in diameter by about 2ft deep, probably approaching a half sphere in shape, and containing approximately ½ cubic yard of material. It is estimated that about 10 lb of explosives were used for each cubic yard of material removed, and there were about 40 cubic yards removed in all. This large amount of explosives is evidence that only 10 to 15 per cent of the available energy went into breaking up the rock.

The maximum charge for any one blast was six 7½ lb charges situated along the north wall of the caisson. A total of ten charges were placed at various locations along the wall and in various sizes from 1½ lb to 7½ lb per shaped charge. In spite of the precautions used subsequent inspection disclosed that considerable damage had been done. Divers who were sent down found some large cracks at the junction of the interior 2ft 6in walls with the outside 3ft walls. There was also evidence that the steel plate cutting edge which encased the bottom 13ft of the walls was ruptured at one point.

The evidence of rupture was so strong in the six northerly cells that repairs and strengthening were necessary to remove any doubt of structural stability. The bottom 25ft of the caisson cells were to be filled with tremie concrete in accordance with the original plans. This portion of the caisson was considered satisfactory after placing of this bottom seal. To repair the six northerly cells from the top of the concrete seal upward, it was decided to fill them with concrete to a height where there was little or no damage. The two corner cells were filled to elevation 35ft below sea level and the four centre cells along the north edge to elevation 60ft below sea level. This work required a total of 2350 cubic yards of concrete to be added to this caisson. The other two caissons were lowered into position without any of the difficulties encountered at pier No. 2.

The bottom 13ft of the concrete walls of each caisson are protected by structural steel cutting edges fabricated from ⅜in, ½in and ¾in thick steel plates by welding. These steel cutting edges, which weighed about 400,000 lb per caisson, were fabricated at the Bethlehem Pacific Coast Steel Shipbuilding Yards in San Francisco, 32 miles from the bridge site. The sections were assembled on a shipbuilding drydock and welded together. Then the cutting edges were filled with concrete and the outside walls of the caisson were extended to a total height of 31ft by placing 4in precast slabs around the periphery. The use of these 4in precast slabs was an innovation developed by the contractor for reinforced concrete caisson construction. The slabs were precast by the Basalt Rock Company and became an integral part of the 3ft thick outside wall when the caisson was completed. The slabs were cast in section 10ft high by 16ft long, and reinforced at mid-section with ⅜in vertical bars on 11in centres and ⅜in horizontal bars on 6in centres. The outside surface was cast smooth, but the inside surface was roughened and keyed for bonding to the poured-in-place section of the outside wall.

To support the slabs, small vertical steel trusses 25½in deep were fabricated and cantilevered up from the concrete and steel cutting edge below. The slabs were then secured to these trusses, and the horizontal reinforcing bars in the slabs were welded together at the joints between slabs. After erection there remained in the vertical joints an opening of ¼in to ½in. At the horizontal joints the slab edges were seated on each other and there was no clear opening. To seal these joints and make them watertight, the contractor used a commercial application of glass-fibre fabric and glass-fibre sealing compounds.

There are several advantages obtained by this type of construction. It greatly reduces the weight of the caisson by making the top 20ft section of the outside wall 4in thick as compared to 36in, thereby improving its buoyancy. Then, too, the precast slabs save the time and expense of placing and removing form work. This tends to speed up construction at the bridge site during caisson sinking. A safety factor is also provided since the slabs can be placed quickly and the joints sealed to provide additional freeboard and buoyancy should the need arise.

As mentioned above, the bottoms of dredging wells were closed with "false bottoms" fabricated from heavy timbers. Through each of these "false bottoms" was placed a short section of 30in steel pipe, inside of which there was a supplementary "false bottom" in the form of a concrete plug that could be removed and replaced when desired. After the caisson had been made seaworthy, the drydock was lowered into the water and the caisson was floated out and towed to the bridge site. The first caisson, for pier 2, was manœuvred into position on July 16, 1956.

For concreting the caissons, the contractor constructed on the south shore a concrete plant with a capacity of 120 cubic yards per hour. Concrete was discharged into 6 cubic yard buckets and transported to the piers in three specially constructed barges capable of carrying eight buckets each. About twenty minutes were required from the time the barge left the mixing plant until cranes picked up the buckets for unloading into the concrete hoppers at the pier. For placing concrete in the pier walls and partitions, two concrete hoppers were set up, one at the centre of each half pier. Each hopper discharged on to a belt conveyor which could be turned and extended to discharge at any point on the half pier. One 10ft section of pier could be poured in one day. About four days were required to allow the concrete to set, to move forms, and to place reinforcing for the next 10ft section, so that the sinking operations proceeded at the rate of about 10ft per week.

(To be concluded)

Commercial Aircraft Costs

THE direct operating costs of aircraft in domestic airline service in the United States for the twelve months ended June 30, 1958, on a basis of total cost per aircraft mile, show that a turbine aircraft was the cheapest four-engine machine in service. This machine was the Vickers "Viscount" V.745, operating as a forty-four or forty-six seat carrier. The cheapest aircraft tabulated were as follows :

Aircraft	Flying operations	Direct maintenance	Applied maintenance burden	Depreciation	Total
Douglas D.C.-3	37·38	13·88	6·95	2·97	61·18
Lockheed "Lodestar"	36·22	17·30	18·92	0·72	73·16
Vickers "Viscount"	41·15	17·98	8·90	17·62	85·65
Martin 4-0-4	44·11	19·96	10·62	5·07	85·78
Convairliner 240	45·76	19·47	17·41	6·56	89·20
Curtiss-Wright (CW20) C-46	39·96	22·50	11·64	15·48	89·58

It will be observed that the itemised entries for the Martin 4-0-4 indicate a total lower than that of the "Viscount"; this is, however, illusory because the 85·78 cents includes 1·02 cents for interchange aircraft expense. All the piston-engined aircraft with costs below 90 cents per mile are twin-engined : as an indication that it is not merely the small size of the turbo-prop ("Jet-Prop" is the Vickers term) that brings it into this cost range, it may be pointed out that among the four-engined transports, only the D.C.-6A and D.C.-6B, with eighteen-cylinder poppet-valve radials, have lower direct maintenance costs. It should be borne in mind that these are domestic carriers' costs, and that all operations other than those of the "Viscount" contribute to the fuel tax.

Personal and Business

Appointments

THE WIMPEY ORGANISATION has appointed Mr. Derek Selby as press officer.

MR. D. C. GUNN has been appointed chief engineer to Cochran and Co., Annan, Ltd.

MR. S. M. ORR has been appointed works manager of the pipe fabrication division of Steels Engineering Installations, Ltd.

MR. F. J. BUTLER has joined the sales staff of Bowmaker (Plant), Ltd. He is in charge of the newly-formed training school.

MR. NEIL E. BROWN has been appointed manager of the ship-repairing department of Smith's Dock Company, Ltd., at South Bank-on-Tees.

MR. F. W. KENDRICK has been appointed London representative of John Dore and Co., Ltd., in succession to Mr. R. S. Flexen, who died on April 1.

MR. KENNETH MCMAHON, M.I.P.E., has been appointed to the board of the Hepworth and Grandage Group of Companies, in the capacity of works director.

MR. HERMAN BAKER, Far East regional manager for Marconi's Wireless Telegraph Company, has been appointed managing director of Marconi (South Africa), Ltd.

SMART AND BROWN (MACHINE TOOLS), Ltd., has appointed Mr. Ian T. Jackman as senior sales representative, operating from 25, Manchester Square, London, W.1.

MR. G. H. JOHNSON has been appointed export manager of Bakelite, Ltd., in succession to Mr. E. J. Lassen, who has retired after twenty-eight years' service with the company.

MR. GORDON HYSON, A.M.I.E.E., has been appointed manager of the Bradford branch of Johnson and Phillips, Ltd., in succession to Mr. J. W. Robertshaw, A.M.I.E.E., who retired on March 31.

THE NEWCOMEN SOCIETY has appointed Mr. A. Stowers, immediate past-president, to act as president for the remainder of the session, following the death of the president, Mr. L. E. Harris, on April 5.

FAWCETT PRESTON AND CO., Ltd., has announced that Mr. C. Smith has been appointed contracts manager in the electrical division, and Mr. A. J. Taylor has been appointed sales office manager.

PRATT PRECISION HYDRAULICS, Ltd., announces that Dr. D. F. Denny has been appointed to the position of chief technical executive responsible for design and development of the company's products.

MR. VICTOR BRENNER has been re-elected president for the fourth year, of the Engineering Centre, Birmingham. Mr. C. J. Grazebrook has been re-elected vice-president, and Mr. A. G. Banks, treasurer.

MR. GEORGE LAING has been appointed a director of Miller Insulation and Engineering, Ltd. He will continue as technical adviser and also be in charge of the company's London office at 6–8, Upper Thames Street, E.C.4.

THE MINISTRY OF SUPPLY announces that Mr. L. Boddington has been appointed director-general of aircraft research and development (R.A.F.) in succession to Air Vice-Marshal P. S. Blockey, whose tour of duty in the Ministry ends in July.

PROFESSOR A. R. J. P. UBBELOHDE, professor of thermodynamics at the Imperial College of Science and Technology, has been appointed director of the Salters' Institute of Industrial Chemistry on the retirement of Sir Alfred Egerton, on June 30.

MR. R. A. SENIOR has been appointed director and manager of John Thompson Instrument Company, of Wolverhampton. Mr. C. S. Gilbert has moved from Wolverhampton to Manchester, from where he will service the North of England as sales engineer.

AVRO, Ltd., announces that Sir Charles Westlake, Mr. John Black and Mr. H. O. Houchen have joined its board of directors. They replace Mrs. E. Rawlings, Mrs. M. Brook and Mrs. I. E. Widdows, who have resigned. Sir Charles becomes chairman of the board.

THE MINISTRY OF TRANSPORT AND CIVIL AVIATION announces that Mr. B. P. H. Dickinson has been promoted to Under-Secretary and has taken over the shipping operation ports and planning group from Mr. W. Graham, who retired on March 31 and is taking up an appointment with the Inter-Governmental Maritime Consultative Organisation. Mr. C. P. Scott-Malden has been promoted to Under-Secretary and has taken over the road transport and international inland transport group from Mr. J. E. Hampson. The Ministry also announces that the Secretary of State for Scotland has nominated Professor D. F. Macdonald to be a member of the special panel of the Transport Tribunal in succession to the late Mr. J. M. Mitchell.

Business Announcements

WELDCRAFT, Ltd., has moved to Windsor Works, Slough, Bucks (telephone Slough 23201).

THE INSTITUTION OF ELECTRICAL ENGINEERS states that its telephone number has been changed to Covent Garden 1871.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., states that the telephone number of its Bournemouth depot has been changed to Bournemouth 36223.

MR. Y. B. CHAVAN, chief minister Bombay State, officially opened the new Kanjur Works of Crompton Parkinson (Works) Private, Ltd., on February 28.

WILLIAM BEARDMORE AND CO., Ltd., announces that Mr. D. M. Cameron and Captain Q. H. Paterson have retired from office as directors of the company.

DESIGN RESEARCH UNIT, 37, Duke Street, London, W.1, has opened an office in Lombard House, 3, Higham Place, Newcastle upon Tyne (telephone Newcastle 610051).

METAL INDUSTRIES, Ltd., has announced that it is closing one of its smaller subsidiaries, Ferrous Castings, Ltd., Warrington, Lancashire. The closure will not take place until July.

THE SIMMS MOTOR AND ELECTRONICS CORPORATION, Ltd., states that it has acquired the whole of the issued share capital of Aircraft Steel Structures, Ltd., Western Avenue, Middlesex.

THE FAIRFIELD SHIPBUILDING AND ENGINEERING COMPANY, Ltd., has moved from 9, Victoria Street, Westminster, London, S.W.1, to Grand Buildings, Trafalgar Square, London, W.C.2 (telephone Trafalgar 4433).

MR. C. W. ALLIN, managing director of Redler Conveyors, Ltd., is visiting existing Redler installations in Uganda, Kenya and Tanganyika with the company's East African representative, Gilfillian and Co., Ltd., of Nairobi.

SHORT AND MASON, Ltd., has opened a branch office at 30A, London Road, Manchester, 1 (telephone Central 3044). Mr. William K. Gregson has joined the company as Northern area representative and may be reached at this address.

F. PERKINS, Ltd., has announced the formation of a new subsidiary company, Perkins Engines, Ltd., to handle sales and servicing of Perkins vehicle, agricultural, marine and industrial engines throughout the world. The address of the new company is Peterscourt, Peterborough.

THE PYRENE COMPANY, Ltd., 9, Grosvenor Gardens, London, S.W.1, has formed a new wholly-owned subsidiary company, Pyrene-Panorama, Ltd. The new company will take over as a going concern from Panorama Equipment, Ltd., Panorama Equipment (Export), Ltd., and Industrial Protection, Ltd., the manufacturing and selling of safety glasses, goggles, helmets and other safety equipment.

THE GENERAL ELECTRIC COMPANY, Ltd., has formed a new company G.E.C. Overseas Services, Ltd., which will cover both the supply of goods and the provision of the associated service requirements in certain overseas contracts. The new trading organisation will undertake the bulk of the work formerly handled by the G.E.C. Business Development Department, and that department has, therefore, been discontinued. The directors of G.E.C. Overseas Services, Ltd., are Mr. Leslie Gamage, Mr. D. G. W. Acworth, Mr. R. N. Millar and Mr. H. C. Margrett, who is also the general manager.

Contracts

THE CHEMICAL ENGINEERING DIVISION OF W. C. HOLMES AND CO., Ltd., has received an order from the South Eastern Gas Board for a 16,000,000 cubic feet per day benzole recovery and desulphurising plant. The plant is to be installed at the Isle of Grain works.

THE SOUTH DURHAM STEEL AND IRON COMPANY, Ltd., has received an order for steel pipes, for delivery during the early part of 1960, worth approximately £1,000,000 at current level of prices. The contract comprises the supply of 48 miles of 30in and 20in steel pipe, 40ft in length, for the Lion Supply Company, Ltd., (British Columbia Electric Company, Vancouver).

BRITISH INSULATED CALLENDER'S CABLES, Ltd., has been awarded a contract worth about £250,000 for the supply and installation of telephone cables for Phases 3, 4 and 5 of the Crewe–Manchester 25kV, 50 c/s electrification in the London Midland Region of British Railways. These phases will practically complete the Crewe–Manchester telephone cable system, providing the remaining main cabling between Wilmslow and Manchester and in the environs of Crewe station. The specially screened telephone cable will be of the same kind as installed by B.I.C.C. in the earlier phases. The cables are sheathed with drawn seamless aluminium and provided with heavy steel tapes for electromagnetic screening against induction from the 50 c/s a.c. traction supply. Earthing of the screen in the existing installations has been provided by the B.I.C.C. system of deep-driven copper rods.

THE value of recent orders for winders placed by the National Coal Board with The General Electric Company, Ltd., now totals nearly £400,000. The orders include two winders for the Birch Coppice Colliery, rated at 400 h.p. and 1490 h.p. The larger winder is of particular interest in that speed control is effected by a grid-controlled mercury-arc rectifier. The other three winders are : a 1450 h.p. machine for Western Colliery ; one of 1900 h.p. for Caerau Colliery, and another of 1100 h.p. for Cortonwood, for which a 2000 h.p. winder is already on order. With the exception of the 1490 h.p. rectifier winder, all the equipments are a.c. and have compensated dynamic braking. Mechanical parts of the Cortonwood winder are being supplied by Fullerton Hodgart and Barclay, Ltd., and of the other four winders by Robey and Co., Ltd. These orders follow closely on contracts recently announced for five winders valued at over £600,000, for which the G.E.C. is supplying both the electrical and mechanical parts.

MARCONI'S WIRELESS TELEGRAPH COMPANY, Ltd., is to supply three high-power h.f. communications transmitters to the Posts and Telegraphs Department of Pakistan to provide additional telegraph and teleprinter circuits for the Overseas Telecommunications Service. The equipments have been ordered as part of the extensive programme which the Post and Telegraphs Department has in hand for the expansion of radio telecommunications on international circuits and between East and West Pakistan. Apparatus to be supplied includes a Type HS51 30kW transmitter and two Type HS72 10kW transmitters, complete with drives for independent sideband telephony and frequency-shift keying. The transmitters are motor-tuned for selection of any one of six separate frequencies. The Type HD20 and HD51 drives will be installed in a separate screened room. Outputs from the frequency shift keyer and independent sideband drive are both at a frequency of 3·1 Mc/s and are fed by screened coaxial cables to the mixer and harmonic generator chain in each transmitter, the appropriate drive being selected as required by simple U-link cross-patching. The radiated frequency is obtained by feeding into the same mixer the drive frequencies obtained from the crystal oscillators in the Type HD20 assembly.

THE NORTH OF SCOTLAND HYDRO-ELECTRIC BOARD has placed contracts for the main civil engineering works of the Loch Glashan scheme on Lochfyneside and for the plant of the four stations of the Strathfarrar and Kilmorack scheme in Inverness-shire. William Tawse, Ltd., Aberdeen, has been given the contract to build the dam at Loch Glashan and collecting aqueducts, the tunnel, pipeline and the generating station. Reed and Mallik, Ltd., will construct a system of collecting aqueducts and other works to make use of the upper River Add and River Tunns, and James Young (Contractors), Ltd., Glasgow, will construct aqueducts and other works on the headwaters of the River Crarae. The civil engineering consultants for the Loch Glashan scheme are Messrs. Crouch and Hogg, Glasgow, and the electrical and mechanical consultants are Messrs. Strain and Robertson, Glasgow.

The first Strathfarrar plant contract is for four 10MW Kaplan turbo generators to be installed in the Aigas and Kilmorack power stations. These two power stations, which will each have a capacity of 20MW will be situated on the River Beauly. The alternators will be manufactured by Bruce Peebles and Co., Ltd., Edinburgh. The turbines will be designed by Boving and Co., Ltd., and made under sub-contract in the west of Scotland. Generating plant at the Culligran power station in lower Glen Strathfarrar consisting of a 30,500 h.p. Kaplan turbine driving a 22MW generator will be made by Harland and Wolff, Ltd., as sub-contractor to the English Electric Company, Ltd. At the Deanie power station, 6 miles further up the Glen, the plant will consist of two 26,600 h.p. vertical-shaft Francis turbines each driving a 19MW generator. The contract to manufacture and supply these sets has been placed with the English Electric Company, Ltd., who will manufacture the generators at Scotstoun, while the turbines will be made by the Harland Engineering Company, Alloa, as sub-contractors. The electrical and mechanical consultants for the Strathfarrar and Kilmorack scheme are Messrs. Kennedy and Donkin.

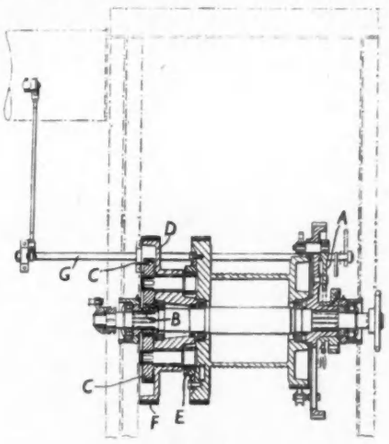
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings, unless otherwise stated. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

CRANES AND EXCAVATORS

810,329. April 25, 1957.—Hoist Drum Control Mechanism, Thomas Smith and Sons (Rodley), Ltd., Crane and Excavator Works, Rodley, Leeds, Yorkshire, and James Thomas Upex, of the company's address.

This invention relates to the mechanism which controls the rotation of the hoist drum for lifting and lowering the load in a crane, or in an excavator, winch or other machine capable of being used as a crane. Its object is to provide a power mechanism for controlling the rotation of the drum in both



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directions to give full mechanical control. Referring to the drawing, which illustrates the application of the invention to the main hoist drum of an excavator to provide power lowering when operating as a crane, the drum is freely rotatable about a driving shaft to which it can be locked by a main clutch *A* at one side of the drum. At the other side of the drum the driving shaft has secured on it a centre pinion *B* engaging with two diametrically opposed planet pinions *C C* which are secured on shafts journalled in bearings in a gear carrier *D* rotatably mounted about the driving shaft. The planet pinion shafts have secured on them auxiliary pinions which engage an internal gear wheel *E* secured to the drum. The gear carrier can be held stationary by a friction band brake *F* operated by a mechanism which may, if desired, be coupled through the shaft *G* with the operating mechanism for the main clutch, both clutch and brake being power operated if desired. With the construction described in the specification, by applying the main clutch the hoist drum is rotated at shaft speed in the same direction as the shaft, the planetary brake *F* on the periphery of gear carrier *D* being "off." If the clutch *A* is released and the brake *F* is applied to the gear carrier, the drum will be rotated in the reverse direction to the shaft and at a much reduced speed. The planetary mechanism enables creeping speed lowering to be effected directly and mechanically without any frictional slip. The double reduction drive permits alternative gear ratios to be fitted, and by varying the brake pressures between the planetary brake and the drum, any speed of lowering can be obtained between zero and maximum. Full gravity lowering is possible, if desired, with both clutch and brake disengaged.—*March* 11, 1959.

INTERNAL COMBUSTION ENGINES

810,456. September 29, 1955.—Liquid Fuel Injection Systems, The British Internal Combustion Engine Research Association, 111–112, Buckingham Avenue, Slough, Buckinghamshire. (*Inventor: Wilfred Percival Mansfield.*)

It is well known that diesel "knock" can be eliminated by injecting a pilot charge of fuel into the combustion chamber of an engine ahead of the main charge, and it is the object of this invention to provide a pilot injection device which is efficient in operation and simple to manufacture. The invention consists in a fuel injection system which includes a fuel injection pump, and a pilot injection device comprising a slidable member moving in a bore and controlling ports in such a manner that the cycle of operations comprises three stages. In the first stage, the predetermined pilot quantity of fuel is discharged into the delivery passage leading to the injector nozzle. In the second stage, fuel is released from the delivery passage on the injector side of the device by placing it in communication with a low-pressure part of the system, and there is a delay period following the pilot injection. In the third stage the injection pump is placed in communication with the delivery passage for the discharge of the main quantity of fuel. A number of embodiments of the device are described with reference to drawings in the specification.—*March* 18, 1959.

CUTTING TOOLS

810,543. July 6, 1955.—Drilling of Metals, National Research Development Corporation, 1, Tilney Street, London, W.1. (*Inventors: William Stephen Hollis and Algernon Raymond Tomlinson.*)

For the machining of hard metals such as "Nimonic," it has been found that difficulties may be overcome or considerably reduced by subjecting the cutting edge or tip of a tool to the action of a coolant medium. The object of the invention is to obtain a better cooling of a drill and to this end a refrigerating medium (such as carbon dioxide) or a refrigerated medium is fed through the drill axially to a point in the vicinity of the working or cutting edges. The invention is illustrated, by way of example, in the drawing. The shank of a drill consists of a thick walled tube with a longitudinal capillary duct or bore, which is chambered at *A* to receive the shank of a cermet or hard metal bit *B* and the duct leads into the chamber. The bit is also provided with an axial bore, which is in alignment with the drill duct. One or more outward extensions from the axial bore of the bit emerge in the vicinity of the cutting edges.

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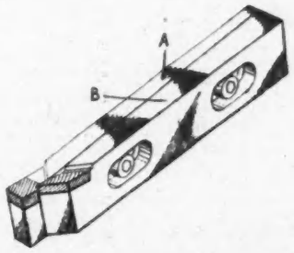
Carbon dioxide or like coolant is fed to the vicinity of the cutting edges of the drill in any convenient manner. As shown, radial holes extend from the duct into an annular chamber *C*, which must be of sufficient height that the radial holes do not pass from it during a drilling operation. The drill can rotate in the chamber to which a coolant medium can be supplied through a pipe, suitable glands being provided to prevent escape of coolant to the atmosphere. According to another construction, the capillary duct extends the entire length of the drill shank whose end remote from the bit may project through a gland into a chamber to which a cooling medium is supplied.—*March* 18, 1959.

810,512. August 12, 1957.—Lathe and Like Cutting Tools, Liverpool Tool and Gauge, Ltd., Ashcroft Road, Kirkby Industrial Estate, Kirkby, near Liverpool. (*Inventor: Fred Leopold Street.*)

Broadly, this invention relates to a cutting tool comprising two parts each consisting of a shank portion with a cutting edge or tip, and clamping means for securing the shank portions in axially adjustable relationship so that their cutting edges form or shape a workpiece in at least two planes.



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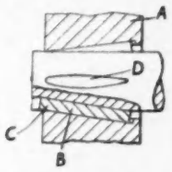
The tool comprises two co-operating parts *A*, *B*, part *A* having a tip set for a facing operation, and part *B* a tip arranged to form a chamfer at 45 deg. The contacting faces of the shank portions of the tool parts are accurately machined with opposite inclinations of the order of 2 deg. and in the shank portion of part *B* are two elongated apertures counterbored to receive the cap heads of bolts. The shank of part *A* is drilled and tapped to receive the bolts by which the two parts of the tool may be firmly clamped together with cutting tips in the required position. By slacking off the bolts the two parts may be moved axially to vary the relative positions of the tips.—*March* 18, 1959.

POWER TRANSMISSION

810,498. March 12, 1957.—Attachment of Hubs to Shafts, Bryce Berger, Ltd., of Ironbarks Works, Staines. (*Inventor: Reginald Stanley Emerson.*)

If serrations, keyways or splines are cut on the periphery of a parallel shaft extending, say, from one end of the shaft to an intermediate point, a zone containing stresses in excess of those in the plain portion of the shaft will be created where the serrations end. It is well known that these excess stresses can be avoided by locally increasing the diameter of the shaft where the interacting faces between the hub and the shaft are formed. It is often undesirable, for reasons such as limitation of space, to provide this local increase of diameter. The present invention has



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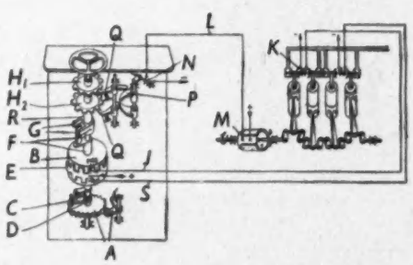
for its object to provide an effective and simple means of securing a hub to a parallel cylindrical shaft so that the shaft can develop its full torsional strength with the minimum risk of fracture due to local high stresses adjacent to the fixing means. In it the keyways are inclined to the axis of the shaft so that at one end both the keys and the keyways are clear of the shaft, whilst at the other end the keys are embedded in the shaft. The drawing shows a longitudinal section through a shaft and hub incorporating the invention in one form. A hub *A* is bored to pass over a shaft, the class of fit between the hub and shaft being unimportant since it plays no part in the transmission of torque. Four mutually coincident keyways are provided in the hub and the shaft for keys *B*. The keys or keyways may be of any convenient number and cross-sectional shape, but the preferred circular section is shown. The keys are inclined at an angle to the axis of the shaft so that at their end *C* they are contained approximately wholly in the shaft, while at their other end they are substantially clear of the shaft. Various alternative means of axial location for the keys may be employed. A counterbore in the hub provides access to facilitate removal of the keys when necessary. The opening *D* shows how the keyways in the shaft break through the surface. The keys also provide positive axial location between the hub and the shaft.—*March* 18, 1959.

ELECTRICAL

810,058. August 1, 1956.—Locomotive Controller, Aktiengesellschaft Brown, Boveri and Cie, Baden, Switzerland.

This invention relates to an arrangement for regulating the stepping of a contact drum which controls an electro-pneumatic drive for multiple contact switches, more especially on electric locomotives. The contact drum for regulating the drive is freely rotatable on the shaft of the master controller and is mechanically coupled thereto through a spring



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coupling; a locking device coupled to the contact drum is electro-magnetically released step-by-step by means of the multiple contact switch only when the latter is in a number of definite positions. Referring to the drawing, when the handwheel of the master controller is moved from 0 to any step, it is

held fast in this position by the arresting device A, the contact drum B being moved through the spring coupling (C, D, E). The drum can at first advance only through one step whereafter the driving member F encounters the claw G held fast by the locking wheel H_1. When the contact drum is in this new position, the line J is placed under voltage. The control valve K of the air motor is energised, so that compressed air is admitted and the air motor is moved through 90 deg., the multiple contact switch travelling from 0 to step 1, and the conductor L being fed through auxiliary contact M on the multiple contact switch. The locking magnet N pulls up. Under the action of the cam P the locking lever Q_1 releases the claw wheel H_1. The locking wheels, the claw R, the driving member F and the contact drum move through one further step under the action of the tensioned spring D, whereafter the locking lever Q_2 which engages with the claw wheel H_2 prevents further movement. In the new position reached, the line S is also fed through the contact drum, which results in a further quarter-turn of the piston motor. The contact step 2 is thus reached. The locking magnet is de-energised and releases the locking wheel and drum controller portion B—H_1 for a further step. This cycle is repeated until the stage pre-selected by the handwheel is reached. In this case, the spring D exerts no further moment on the contact drum and the position of the driving air motor is not further changed. The pair of locking wheels H_1, H_2 completes a further switching step under the action of the pair of tongues G returning into the position of equilibrium and thus enters the initial position necessary for further switching operations. A method of automatic control of the rate of progression is also described.—*March* 11, 1959.

Launches and Trial Trips

CAPTAIN FREMANTLE, trawler; built by John Lewis and Sons, Ltd., for the Iago Steam Trawler Company; length overall 153ft, breadth 28ft, depth 14ft 6in, gross tonnage 448; fishroom capacity 10,000 cubic feet, trawl winch 175 b.h.p., barrel capacity 1000 fathoms 2¾in warp; 147kW trawl winch generator, two 30kW diesel-driven generators; British Polar Mark M46M diesel engine, 960 b.h.p. at 250 r.p.m. Trial, February 18.

IRISH BLACKTHORN, oil tanker; built by the Fairfield Shipbuilding and Engineering Company, Ltd., for Irish Shipping, Ltd.; length between perpendiculars 557ft, breadth moulded 69ft 3in, depth moulded 39ft, deadweight 18,000 tons on 29ft 6in draught, speed 15¼ knots; two 350kW turbo-generators, one 200kW diesel-driven generator; one set of double reduction geared turbines taking steam at 555 lb per square inch and 800 deg. Fah. from two Babcock and Wilcox boilers. Launch, February.

GALWAY, open shelter deck cargo ship; built by Smith's Dock Company, Ltd., for the New Zealand Steam Shipping Company, Ltd.; length between perpendiculars 440ft, breadth moulded 60ft 3in, depth moulded to upper deck 38ft 9in, deadweight 9811 tons on 26ft 7¾in draught, service speed 14¼ knots; five holds, one 30-ton, ten 10-ton and four 5-ton derricks, electric winches; three 200kW diesel-driven generators; Hawthorn-Doxford five-cylinder oil engine, 5500 b.h.p. at 115 r.p.m. Trial, February.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

To-day, April 17.—STOKE AND CREWE BRANCH: Royal Hotel, Crewe, Films, 7.30 p.m.
Sat., April 18.—OXFORD AND DISTRICT BRANCH: St. John's Hall, Marston Street, Oxford, "Refrigeration," 7 p.m.
Tues., April 21.—ALDERSHOT AND DISTRICTS BRANCH: Red Cross Hall, High Street, Aldershot, "Electrical Safety in the Home," S. J. Emerson, 7.30 p.m. ★ EAST KENT BRANCH: County Hotel, Canterbury, "Electricity in Hospitals," A. A. Mansell, 8 p.m.
Thurs., April 23.—SOUTH LONDON BRANCH: Greyhound Hotel, High Street, Croydon, "Rectifiers and their Applications," K. D. Phillips, 8 p.m.
Sat., April 25.—SOUTH EAST LONDON BRANCH: Visit to London Airport, 2.30 p.m.

BRITISH INSTITUTE OF MANAGEMENT

Tues., April 21.—PRODUCTION CONTROL STUDY GROUP: Management House, Fetter Lane, London, E.C.4, "Purchasing Quantities, Stock Levels and Batch Sizes," Miss M. S. Munn, 2.30 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

To-day, April 17.—SCOTTISH SECTION: Department of Natural Philosophy, The University, Drummond Street, Edinburgh, Annual General Meeting, 6.30 p.m.; "Stereophonic Sound and Electrostatic Loudspeakers," D. T. N. Williamson, 7.30 p.m.
Wed., April 22.—LONDON BRANCH: London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, "The Application of Magnetic Resonance to Solid State Electronics," D. J. E. Ingram, 6.30 p.m.
Tues., April 28.—MEDICAL ELECTRONICS GROUP: London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, Two papers on "Electron Microphony," G. Causey and R. S. Page, 6.30 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Wed., April 22.—MIDLAND REGION: Room No. 3, Chamber of Commerce, New Street, Birmingham, "Instrumentation for Industrial Steam Raising Plant," L. I. Young, 10.30 a.m.
Thurs., April 23.—NORTH WESTERN REGION: Engineers' Club, Manchester, "Capital Investment and Fuel Saving Schemes," R. H. Potterill, 2.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., April 20.—BATH AND BRISTOL CENTRE: Gardiner, Sons and Co., Ltd., Showroom, Broad Plain, Bristol, Annual General Meeting, 7 p.m.
Tues., April 21.—LIVERPOOL CENTRE: Merseyside and N. Wales Electricity Board Industrial Development Centre, Liverpool, Annual General Meeting; Film Show, 6 p.m.
Wed., April 22.—LEICESTER CENTRE: Bell Hotel, Leicester, Annual General Meeting, 7 p.m.
Fri., April 24.—BIRMINGHAM CENTRE: Regent House, St. Philip's Place, Colmore Row, Birmingham, "Lighting and Industry in the Soviet Union," E. H. Norgrove, 6 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Tues., April 21.—SLOUGH SECTION: Lecture Theatre, High Duty Alloys, Ltd., Slough, Annual General Meeting; "Modern Developments in Sand Practice," W. B. Parkes, 7.30 p.m.
Wed., April 22.—LONDON SECTION: Constitutional Club, Northumberland Avenue, London, W.C.2, Annual General Meeting; "Water-cooled Basic-cupola Practice," T. C. Wilson, 7 p.m.
Fri., April 24.—SLOUGH SECTION: Afternoon visit to British Bath Company, Ltd., Greenford.

INSTITUTE OF FUEL

Wed., April 22.—Institution of Civil Engineers, Great George Street, London, S.W.1, Presidential Address, T. C. Bailey, 6 p.m.
Thurs., April 23.—Connaught Rooms, Great Queen Street, London, W.C.2, Annual General Meeting; 11.30 a.m., Luncheon, 12.30 p.m.

INSTITUTE OF MARINE ENGINEERS

Tues., April 21.—Memorial Building, 76, Mark Lane, London, E.C.3, Annual General Meeting, 5.30. p.m.
Mon., April 27.—WEST OF ENGLAND SECTION: Grand Hotel, Bristol, Films, "Engineering at Calder Hall," "Criticality," and "Radio-Isotopes in Industry," 7.30 p.m.

INSTITUTE OF NAVIGATION

To-day, April 17.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "The Dectra Trials," C. Powell, 5.15 p.m.

INSTITUTE OF PETROLEUM

Tues., April 21.—LONDON BRANCH: 61, New Cavendish Street, London, W.1, "Oil in the Gas Industry," J. Burns, 6 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Tues., April 21.—NORTH WESTERN BRANCH: Engineers' Club, Manchester, Joint Meeting with the Institute of Petroleum, Paper to be presented by C. P. Williams, 6.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., April 21.—Great George Street, Westminster, London, S.W.1, "Clifton Bridge, Nottingham: Initial Design Studies and Model Test"; "Clifton Bridge, Nottingham: Design and Construction," R. M. Finch and A. Goldstein, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

To-day, April 17.—SOUTH MIDLAND CENTRE: College of Technology, Gosta Green, Birmingham, Discussion on "The Mathematical Content of Advanced Electrical Engineering Courses," opened by N. Mullineux, 6.15 p.m.
Mon., April 20.—EAST ANGLIAN SUB-CENTRE: Assembly House, Norwich, Annual General Meeting, "High-Quality Sound Reproduction," J. Moir, 7.30 p.m. ★ SHEFFIELD SUB-CENTRE: Technical College, Scunthorpe, "Silicone Electrical Insulation," J. H. Davis, 6.45 p.m. ★ WESTERN SUPPLY GROUP: S.W.E.B. Demonstration Theatre, Electricity House, Colston Avenue, Bristol, 1, "The Design of the 330kV Transmission System for Rhodesia," F. C. Winfield, T. W. Wilcox and G. Lyon, 6 p.m.
Tues., April 21.—MEASUREMENT AND CONTROL SECTION: Savoy Place, London, W.C.2, Discussion on "The Problem of Maintenance of Electronic Equipment in the Process Industries," 5.30 p.m. ★ NORTH MIDLAND UTILIZATION GROUP: Great Northern Hotel, Leeds, Joint Meeting with the North Midland Graduate and Student Section, "Uses of Amplidynes," J. Dawson; "Electricity and Milk Production," C. D. Stone, 6.30 p.m.
Wed., April 22.—SUPPLY SECTION: Savoy Place, London, W.C.2, "Electrical Supplies to Power Station Auxiliaries," D. A. Dewison, 5.30 p.m. ★ SOUTH-WEST SCOTLAND SUB-CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "A Train Performance Computer," E. Bradshaw, M. Wagstaff and F. Cooke, 7 p.m.
Thurs., April 23.—ORDINARY MEETING: Savoy Place, London, W.C.2, "Fiftieth Kelvin Lecture, "The Geophysical Year, 1957–58," Sir David Brunt, 5.30 p.m. ★ HATFIELD DISTRICT BRANCH: Technical College, Hatfield, "Cathodic Protection," C. L. Wilson, 7 p.m.
Fri., April 24.—RADIO AND TELECOMMUNICATION SECTION: Savoy Place, London, W.C.2, "Engineering Aspects of Commercial Television Programme Presentation," T. C. Macnamara and B. Marsden, 5.30 p.m.
Mon., April 27.—RADIO AND TELECOMMUNICATION SECTION: Savoy Place, London, W.C.2, "The Field Strengths Required for the Reception of Television in Bands I, III, IV and V," G. F. Swann, 5.30 p.m. ★ SOUTH MIDLAND RADIO AND MEASUREMENT GROUP: James Watt Memorial Institute, Birmingham, Annual General Meeting; "Stereophonic Sound," K. N. Hawke, 6 p.m.

INSTITUTION OF ENGINEERING DESIGNERS

Tues., April 21.—YORKSHIRE BRANCH: Visit to British Transport Commission, Frizinghall Depot, Bradford, 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, April 17.—1, Birdcage Walk, Westminster, London, S.W.1, Symposium on "Biomechanics," 4 p.m. ★ WESTERN BRANCH: Technical Institute, Falmouth, "Mechanical Marshalling of Railway Wagons in Works Sidings," G. W. Grossmith, 7.15 p.m.
Tues., April 21.—SCOTTISH BRANCH: Carlton Hotel, North Bridge, Edinburgh, Repetition of the Graham Clark Lecture, "Engineering in an Expanding Economy," Professor Sir Arnold Plant, 7 p.m.
Wed., April 22.—LONDON GRADUATES' SECTION: 1, Birdcage Walk, Westminster, London, S.W.1, "Rubber in Engineering," P. B. Lindley, 6.30 p.m.
Thurs., April 23.—WESTERN A.D. CENTRE: Royal Hotel, Bristol, "Technical and Practical Aspects of the Disc Brake," J. H. Darling, 6.45 p.m.
Fri., April 24.—LONDON BRANCH: 1, Birdcage Walk, Westminster, London, S.W.1, Annual Meeting; Technical Film Show, 6 p.m. ★ LONDON GRADUATES' SECTION: All-day visit to de Havilland Engine Company, Ltd., Leavesden, Herts.
Fri. and Sat., April 24 *and* 25.—EAST MIDLANDS BRANCH: Portland Building, The University, Nottingham, Spring Meeting.
Tues., April 28.—EDUCATION GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, Discussion on "Extended University Courses for the Better Graduate," 6 p.m. ★ SOUTH WALES BRANCH: South Wales Institute of Engineers, Park Place, Cardiff, "South American Tour," B. G. Robbins, 6 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

To-day, April 17.—SEVENTH AIRCRAFT PRODUCTION CONFERENCE: The University, Southampton, Theme, "The Aircraft Industry —A National Asset."
Tues., April 21.—SOUTHERN REGION: S. Smith and Sons, Motor Accessory Division, Witney, Oxon, "Economic Summary," A. A. Jacobsen, 7.30 p.m.
Thurs., April 23.—SOUTH EASTERN REGION: Royal Commonwealth Society, Northumberland Avenue, Strand, London, W.C.2, "Industrial Relations and the Production Engineer," E. Fletcher, 7 p.m.
Mon., April 27.—NORTH WESTERN REGION: Manchester College of Science and Technology, Manchester, "Productivity in the Cotton Textile Industry," A. Ormerod, 7 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Tues., April 21.—SCOTTISH BRANCH: Institution of Engineers and Shipbuilders, Glasgow, Annual General Meeting, 7 p.m.
Wed., April 22.—LANCASHIRE AND CHESHIRE BRANCH: Liverpool Engineering Society, 9, The Temple, 24, Dale Street, Liverpool, Annual General Meeting, 6.30 p.m.
Thurs., April 23.—11, Upper Belgrave Street, London, S.W.1, "The Engineering Aspects of the Development of Gatwick Airport," F. S. Snow and E. V. Finn, 6 p.m.

INSTITUTION OF WATER ENGINEERS

Wed., April 22.—SOUTH EASTERN SECTION: Institution of Civil Engineers, Great George Street, London, S.W.1, Annual General Meeting; "Maintenance of Steel Trunk Mains and Some Applications of Cathodic Protection," P. G. Spencer, 2.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, April 17.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Some Mechanical Students' Problems," E. Wood, 7 p.m.

MANCHESTER STATISTICAL SOCIETY

Fri., April 24.—Portico Library, 57, Mosley Street, Manchester, "Unfair Queues," F. Downton, 6 p.m.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

To-day, April 17.—Mining Institute, Newcastle upon Tyne, "Some Shipowners' Problems," R. Munton, 6.15 p.m.
Fri., April 24.—Lecture Theatre, Mining Institute, Newcastle upon Tyne, "Speed of Submerged Nuclear-Power-Driven Ships," J. A. Teasdale, 6.15 p.m.

PLASTICS INSTITUTE

To-day, April 17.—MIDLANDS SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, 3, "Fire and Heat Resistant Materials," W. Wilson, 6.30 p.m.

ROYAL STATISTICAL SOCIETY

Tues., April 28.—MEDICAL SECTION: London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1, Discussion on "Matched Pairs," 5.30 p.m.

SHEFFIELD SOCIETY OF ENGINEERS AND METALLURGISTS

Mon., April 20.—The University Building, St. George's Square, Sheffield, Film Night, 7.30 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Tues., April 28.—Manson House, Portland Place, London, W.1, "Measurements in the Photographic Industry," M. E. F. Howarth and P. B. Watt, 5.30 p.m.

WOMEN'S ENGINEERING SOCIETY

Wed., April 22.—Hope House, 45, Great Peter Street, Westminster, London, S.W.1, "Development of the Gas Turbine Aero Engine," A. B. McKenzie, 7 p.m.

Advanced Engineering Courses

Nuclear Reactor Technology. DEPARTMENTS OF ELECTRICAL ENGINEERING AND PHYSICS, Institute of Technology, Bradford. A six weeks' course, presenting in some detail the basic principles of the physics and engineering of nuclear power reactors to those interested or engaged in this field. Monday, April 20, to Friday, May 29. Fee £30.

Production Planning and Control. INSTITUTE FOR ENGINEERING PRODUCTION, "Southfield," 16, Norfolk Road, Edgbaston, Birmingham, 15. This course is intended for industrial executives, senior production engineers and controllers, O. and M. personnel and other specialists in related fields. Methods of production planning and control will be discussed. Monday, April 20, to Friday, May 1. Fee 55 guineas.

Operational Research. UNIVERSITY OF BIRMINGHAM, INSTITUTE FOR ENGINEERING PRODUCTION, 16, Norfolk Road, Birmingham, 15. The general purpose of the course is to enable industrial managers, senior production engineers and operational research and work study specialists, to meet together with leading authorities in the operational research field and to engage upon discussions and group studies on modern developments in the application of operational research to industrial productivity problems. The course will be held from 9.30 a.m. Monday, May 4, to 3.30 p.m. Friday, May 15. Fee for the two-week residential is 55 guineas.

Harwell Reactor School: Course for senior technical executives. REACTOR SCHOOL, ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL, DIDCOT, BERKS. June 15 to 25. Fee, 50 guineas (exclusive of accommodation).

Control and Instrumentation of Reactors. REACTOR SCHOOL, ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL, DIDCOT, BERKS. The course is primarily intended for those who have a direct interest in the control and instrumentation of nuclear reactors, and it will be assumed that participants have some knowledge of the basic principles of these subjects. The course runs from July 7 to 17 inclusive. Fee, 50 guineas (exclusive of accommodation).

Post-graduate Course in Nuclear Power, 1959–60. IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, LONDON, S.W.7. The course is intended for students holding a good honours degree in mechanical, civil, electrical or chemical engineering. It will also be open to applied scientists who have graduated in physics or metallurgy. The course is full-time and of one year's duration. Fee for the full course, £124. Applications should be made before July 1.

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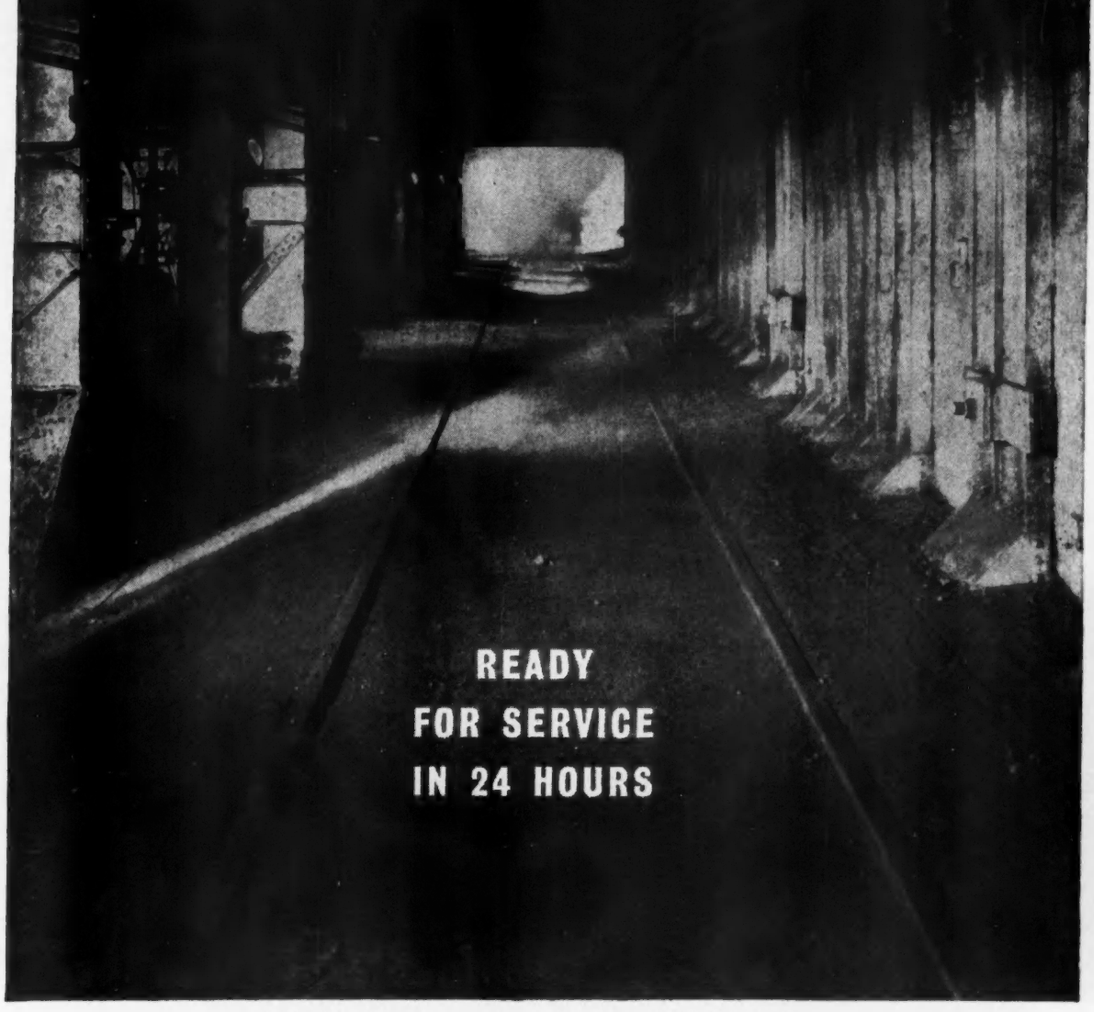

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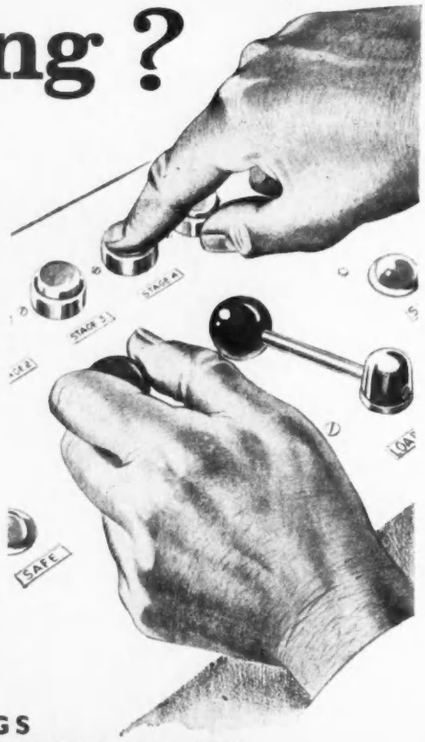

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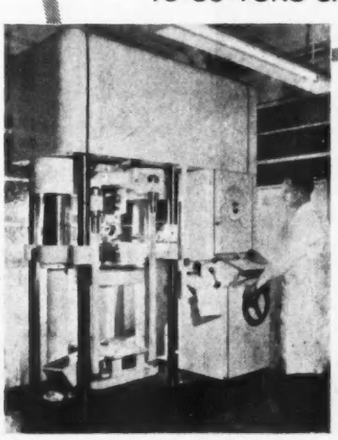

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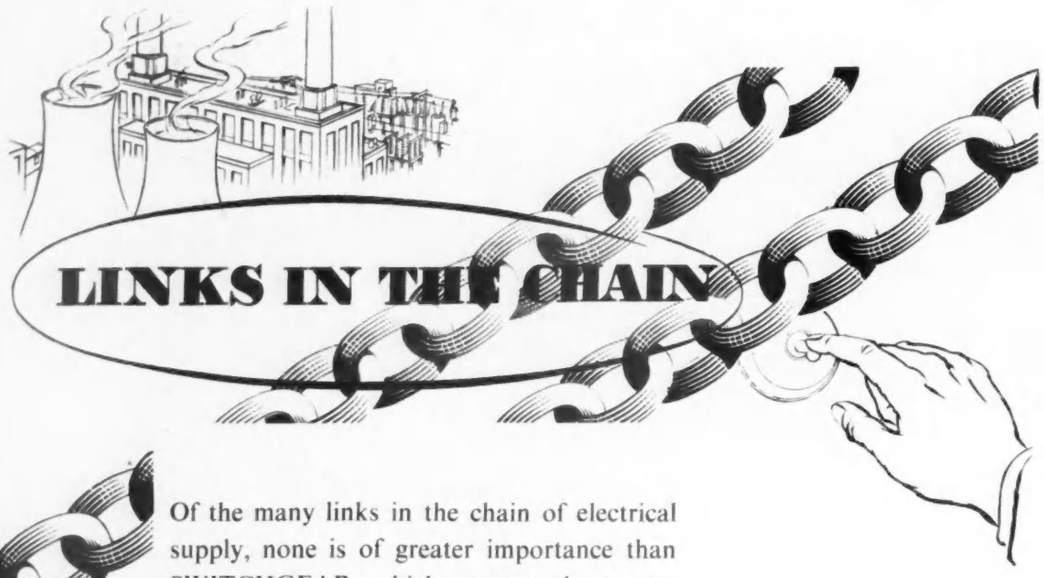

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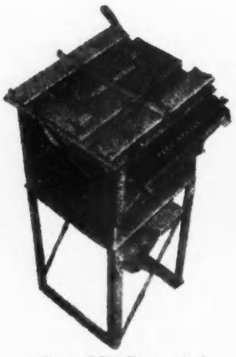

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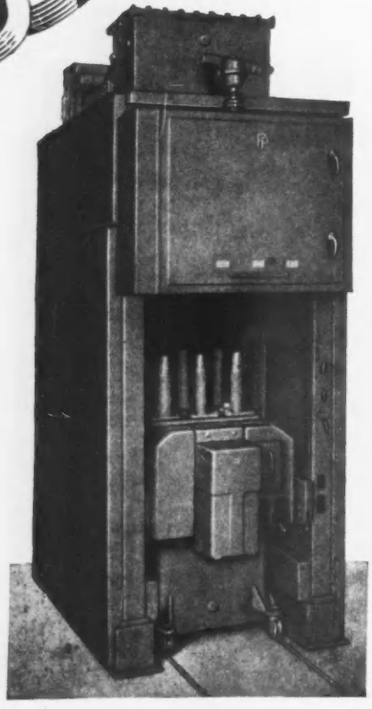

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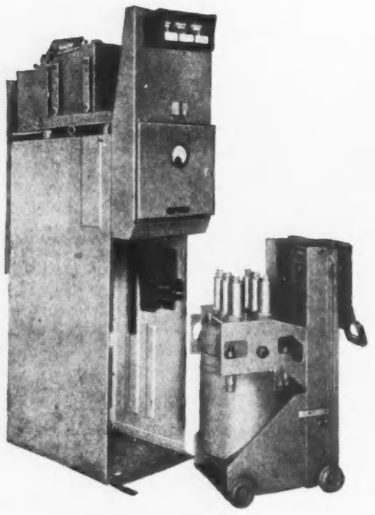

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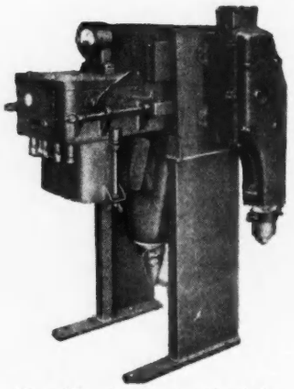

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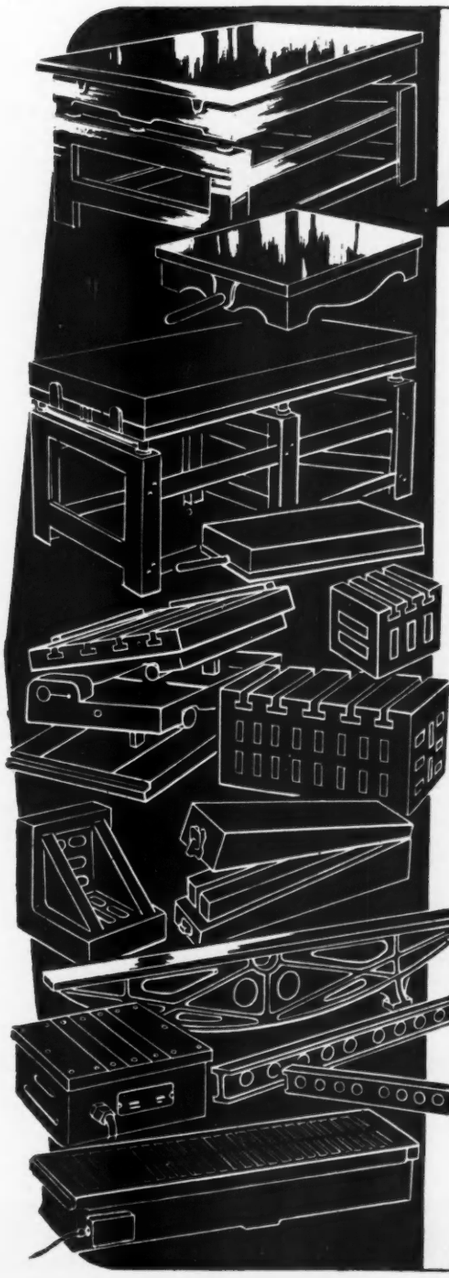

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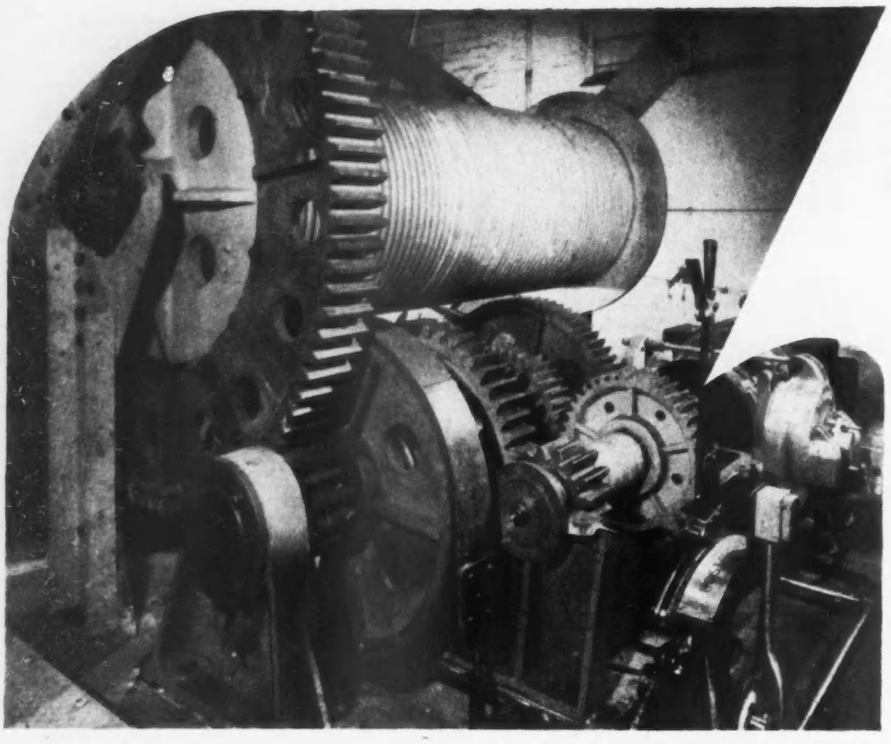

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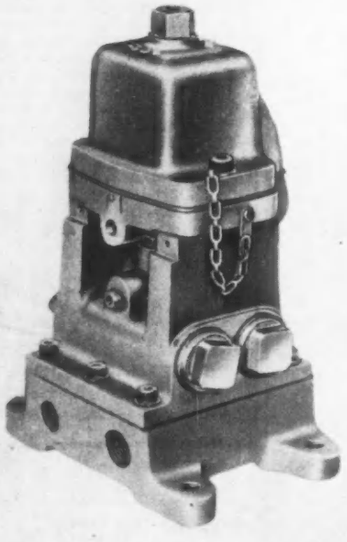

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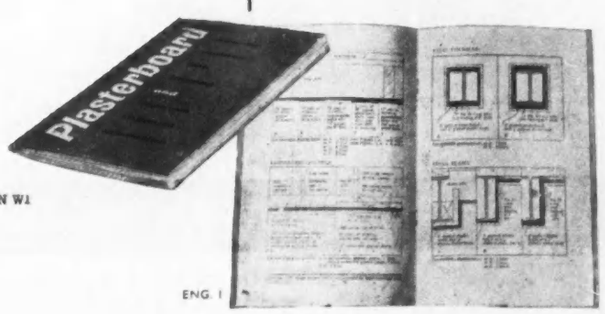

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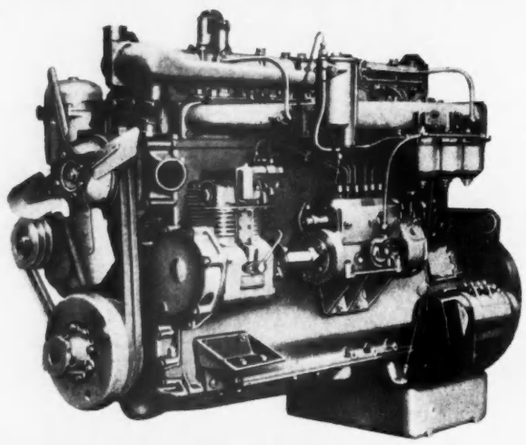

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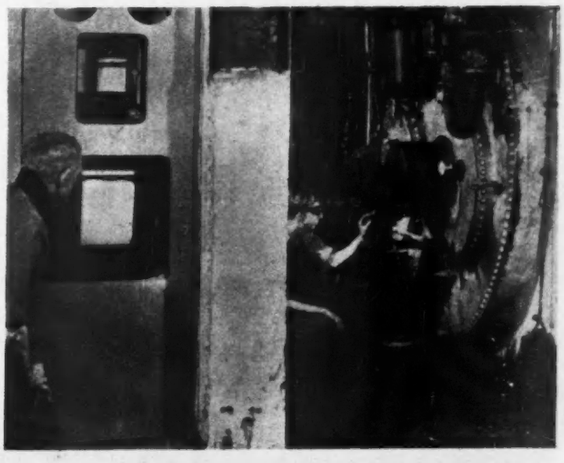

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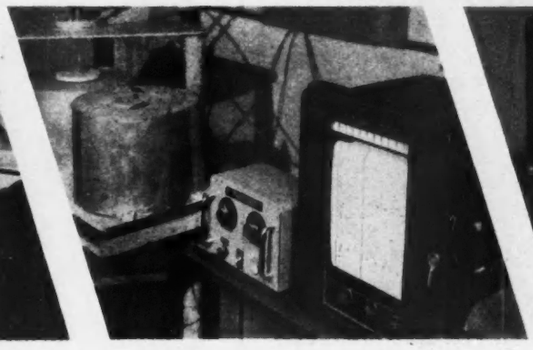

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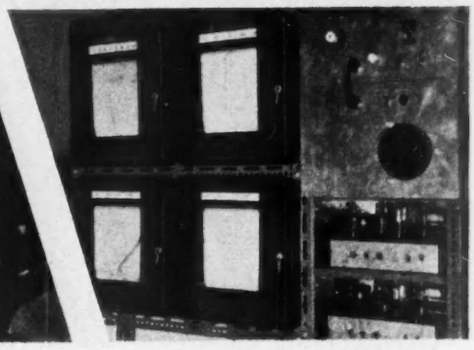

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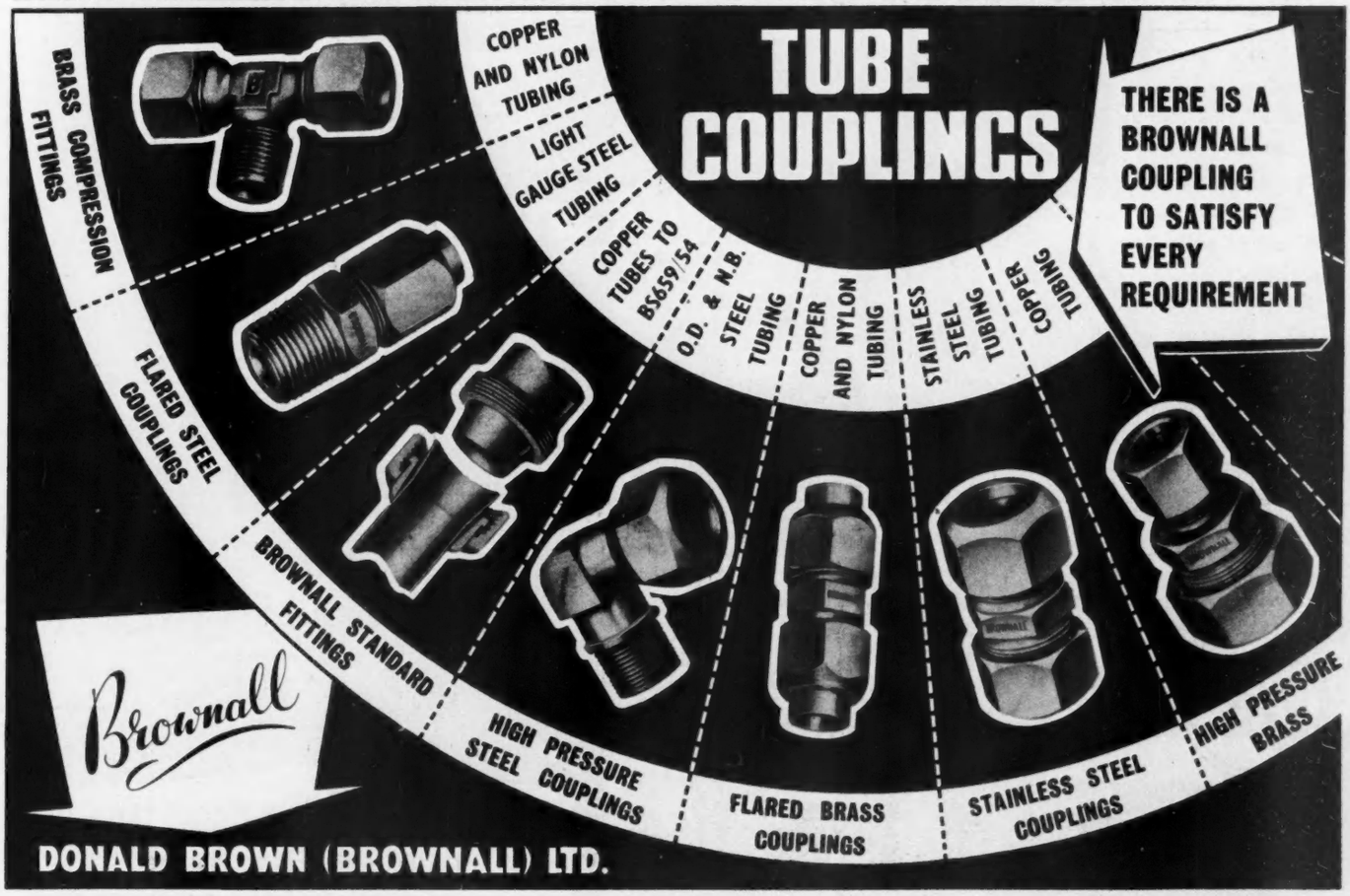

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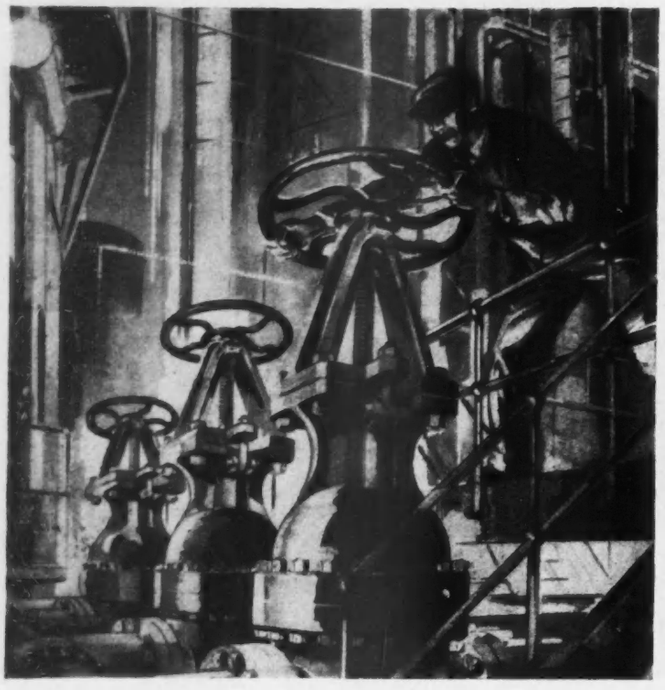

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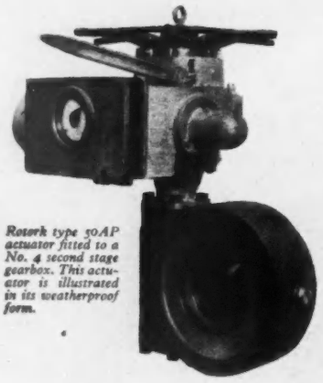

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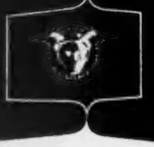

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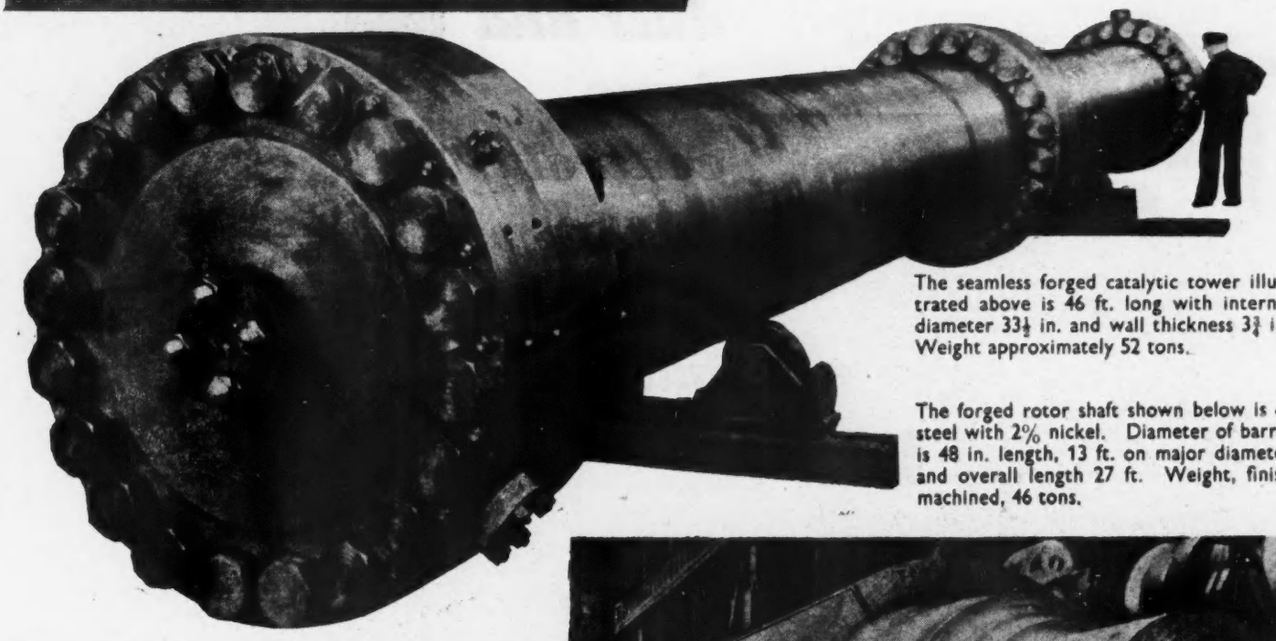
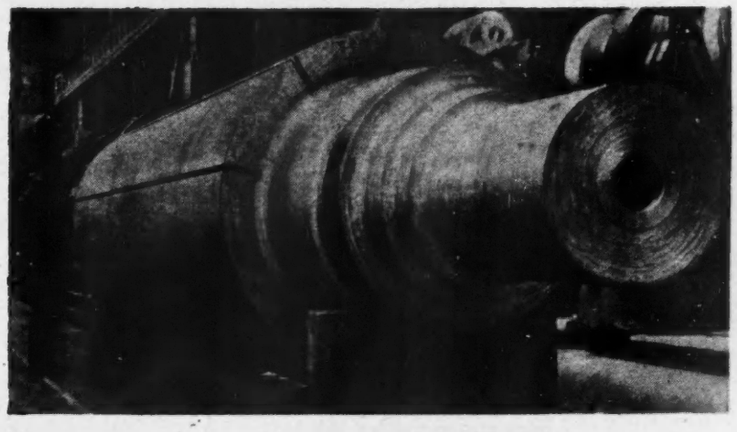


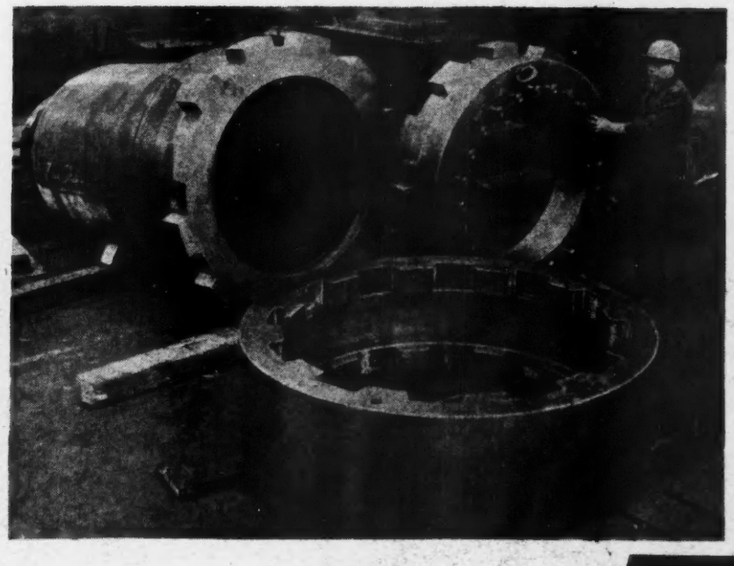
The seamless forged catalytic tower illustrated above is 46 ft. long with internal diameter 33½ in. and wall thickness 3¾ in. Weight approximately 52 tons.

The forged rotor shaft shown below is of steel with 2% nickel. Diameter of barrel is 48 in. length, 13 ft. on major diameter and overall length 27 ft. Weight, finish machined, 46 tons.



Forgings up to a maximum ingot weight of 195 tons can be supplied in all states of finish from "black forged" to finish machined. Steel castings up to 245 tons after fettling and castings of the largest dimensions can be supplied and, if required, can be part or finish machined.

The autoclave illustrated below is of chrome molybdenum alloyed cast steel for a working pressure of 2,414 p.s.i. and controlled temperature 572°F. The largest diameter is 5 ft. 7 in. and height 9 ft. 7 in. Total weight approximately 22½ tons.



This cast steel boss for a Kaplan turbine is 10 ft. diameter × 9 ft. The servomotor cylinder is cast on. Weight approximately 42 tons.

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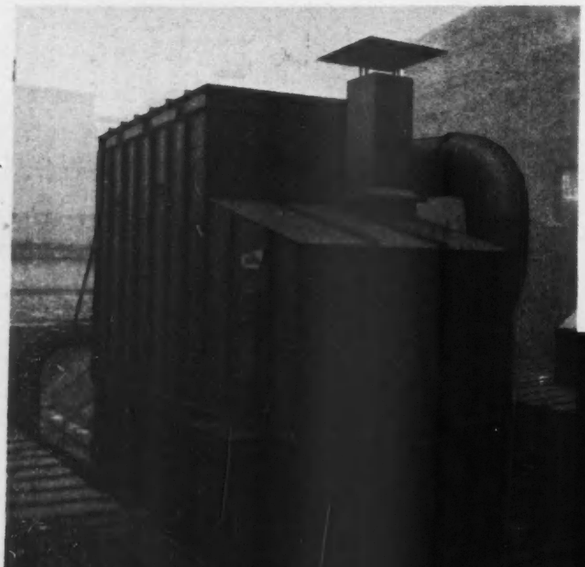
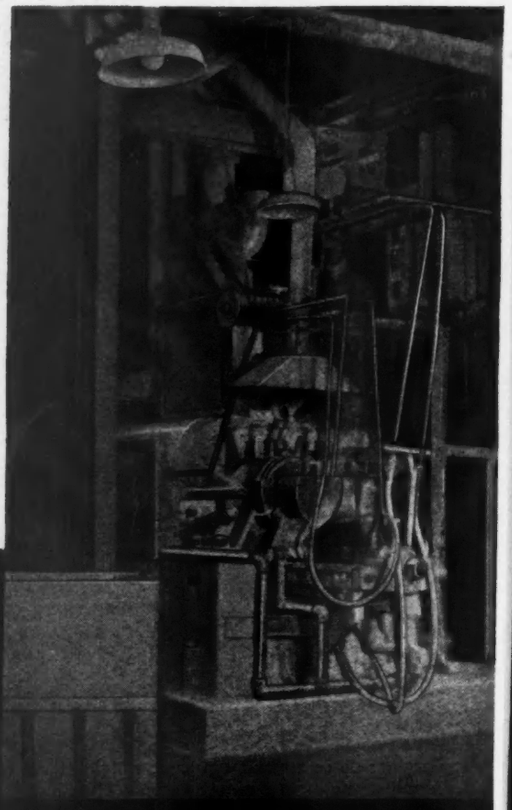
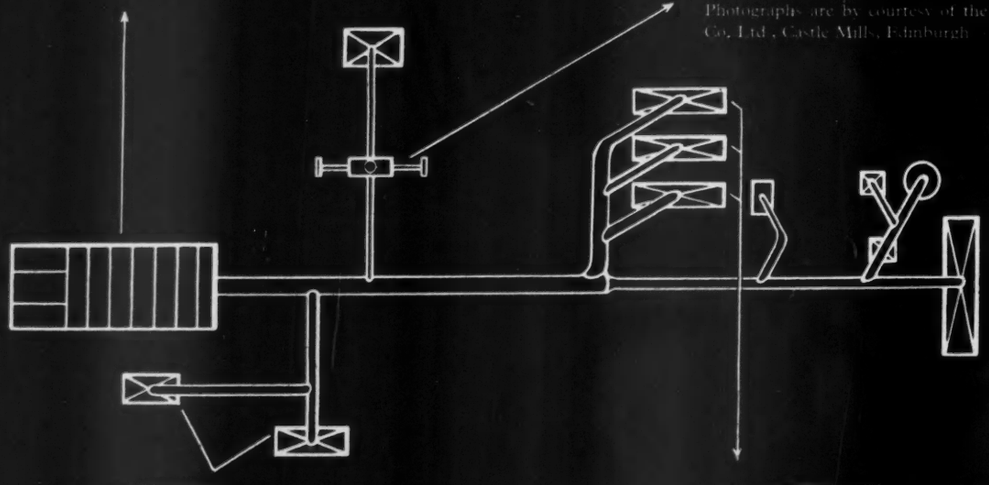
dust and fume control in the rubber industry





Left: Tilghman's intermittent KD type tubular fabric dust collector with integral fan house.
Right: Exhaust from bambury mixer.
Lower left: Exhaust from rubber mills.
Lower right: Exhaust from weighing, mixing and blending department.

Photographs are by courtesy of the North British Rubber Co. Ltd., Castle Mills, Edinburgh



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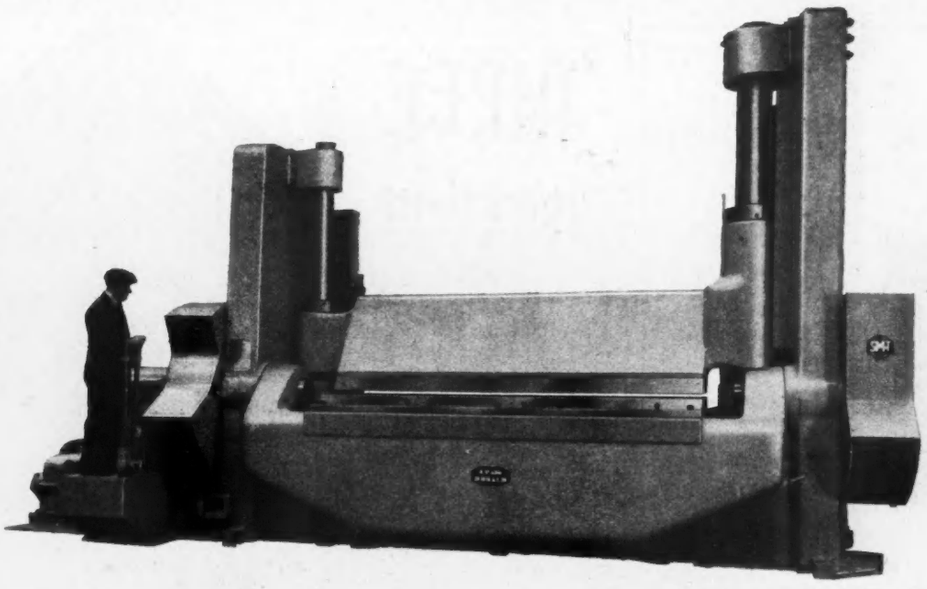

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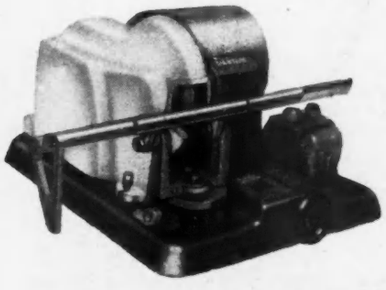

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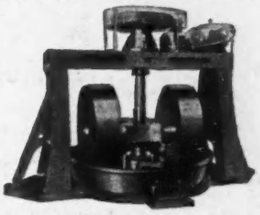

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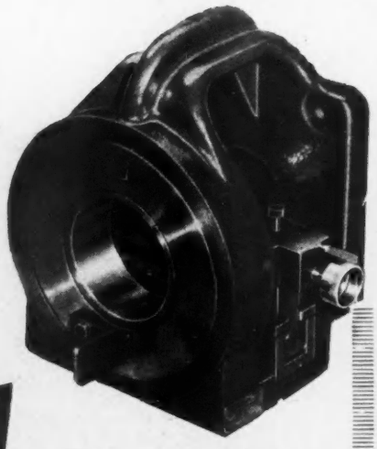

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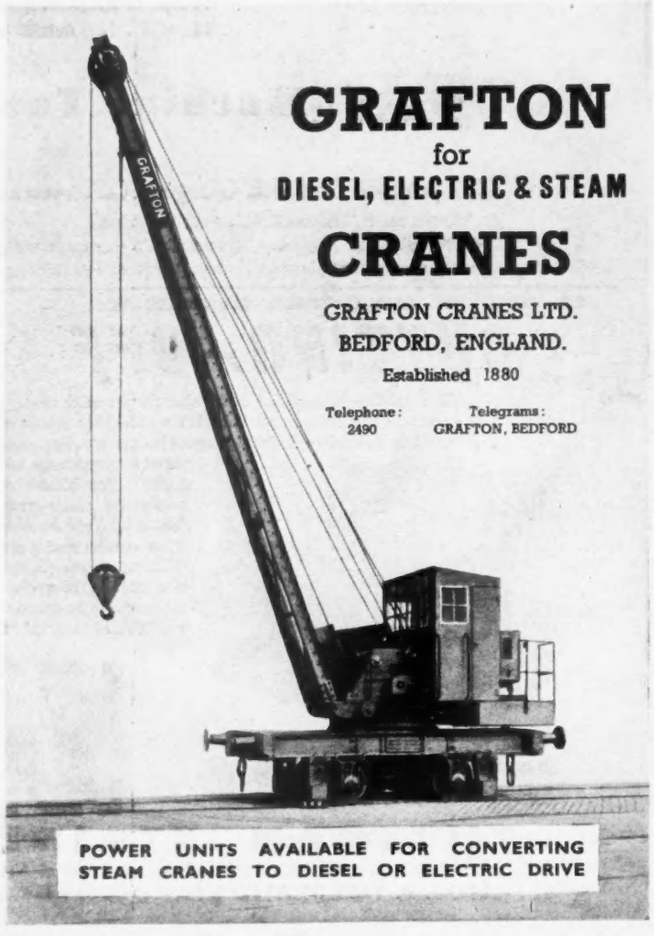

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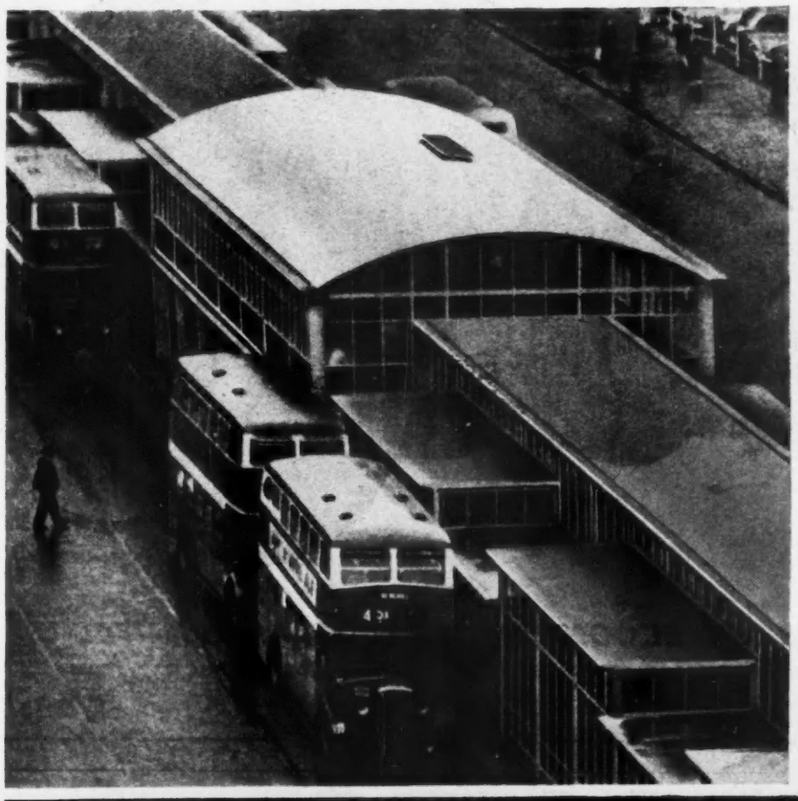

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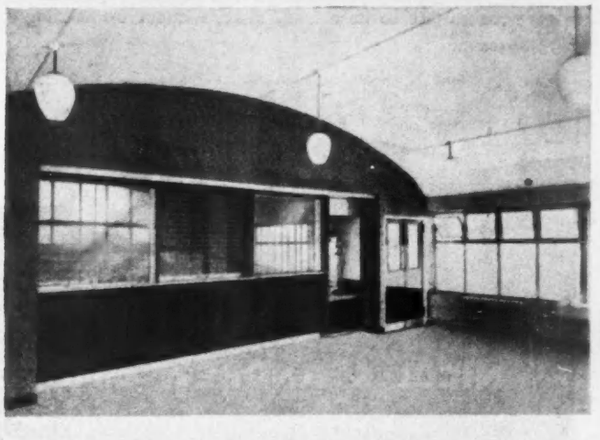

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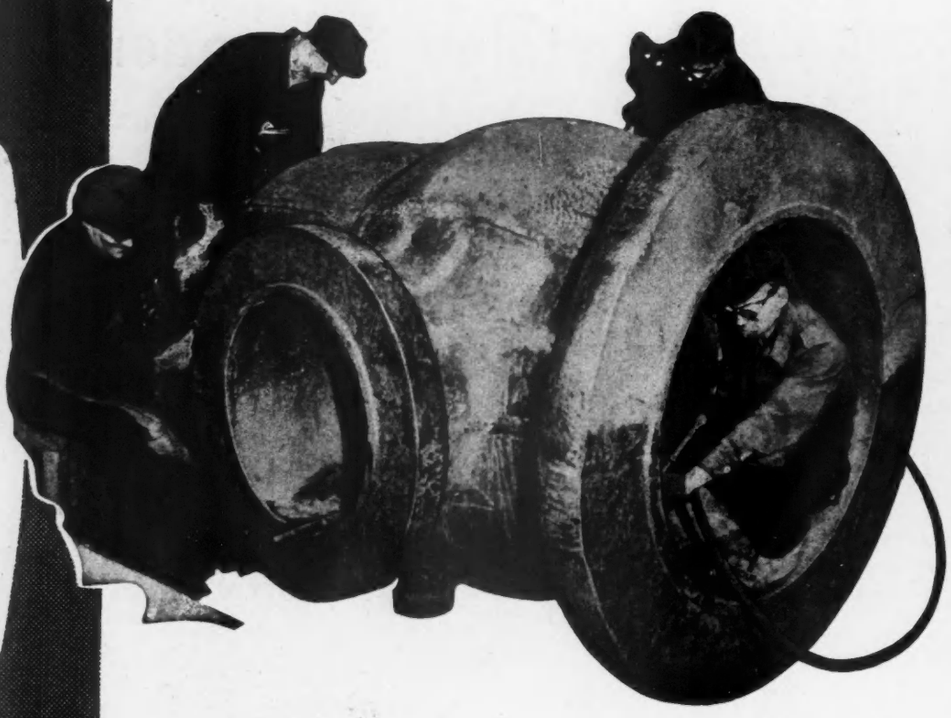

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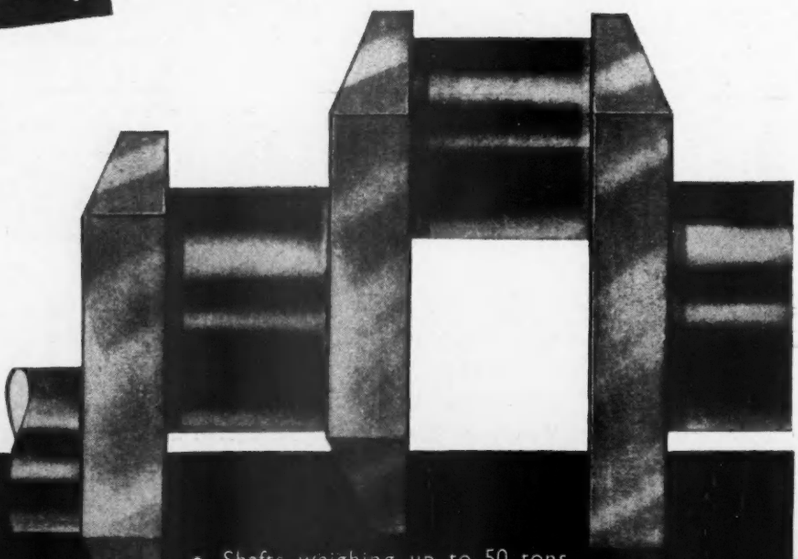

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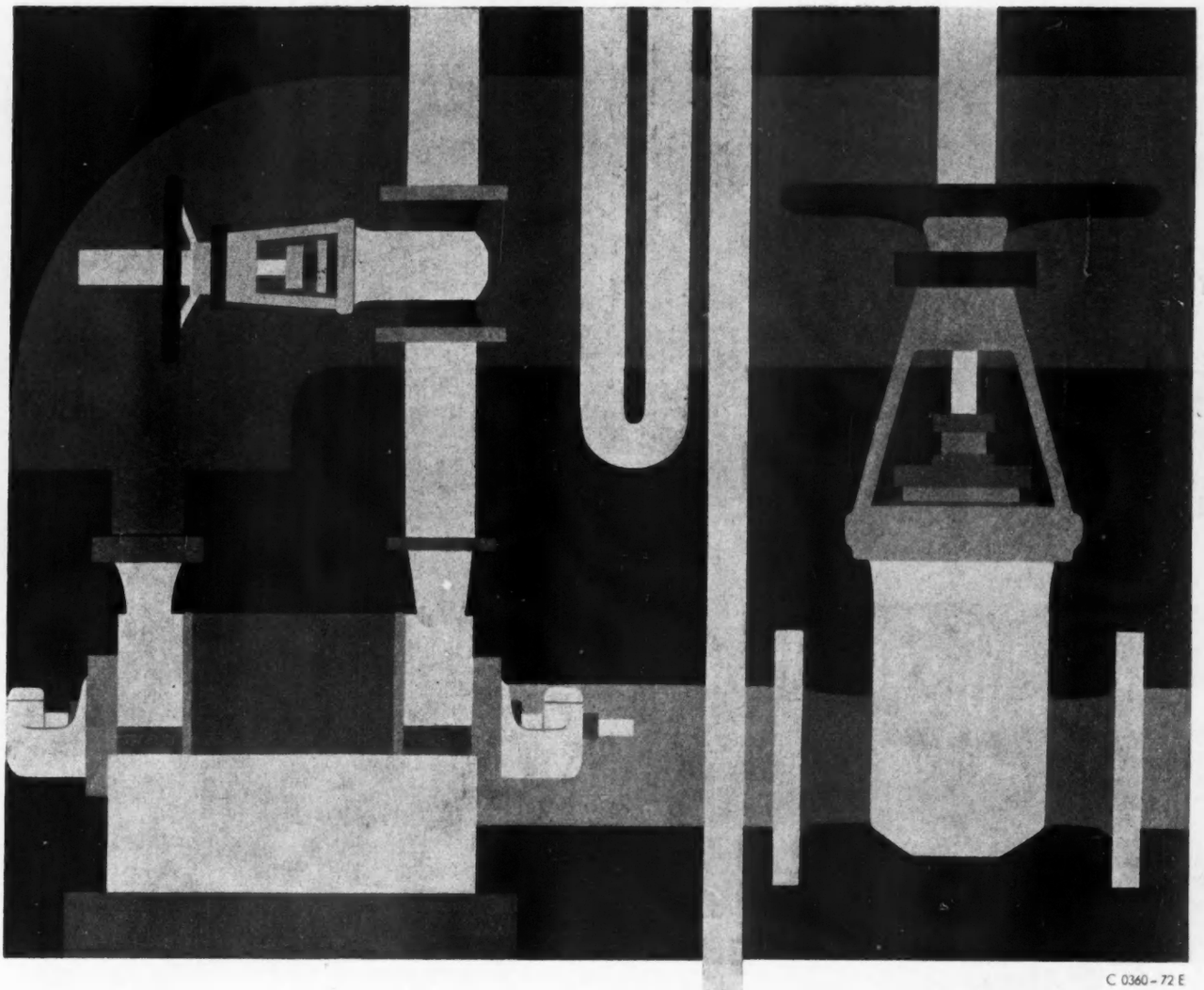

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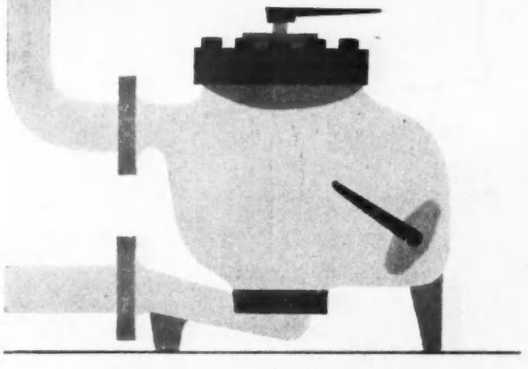

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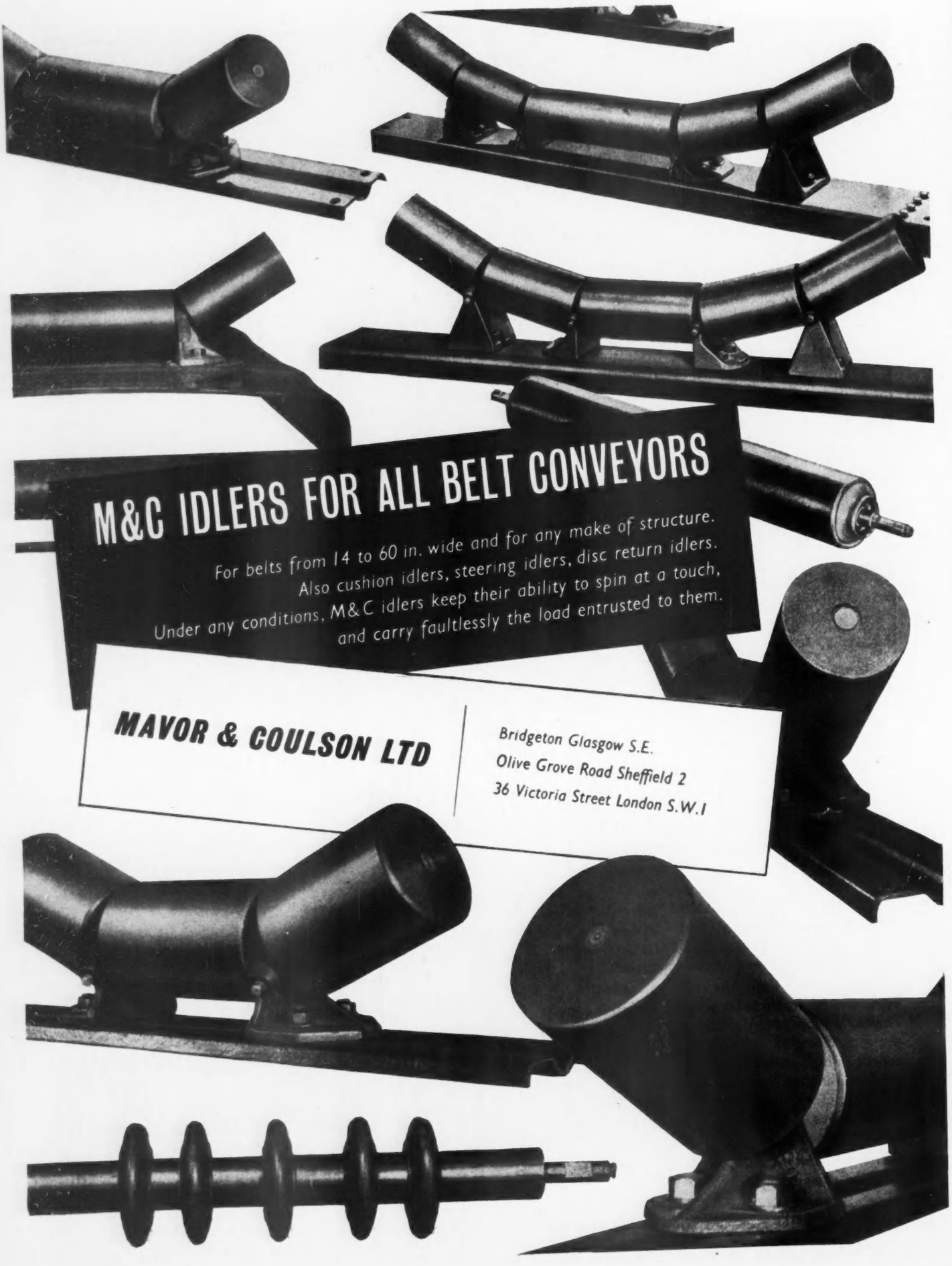

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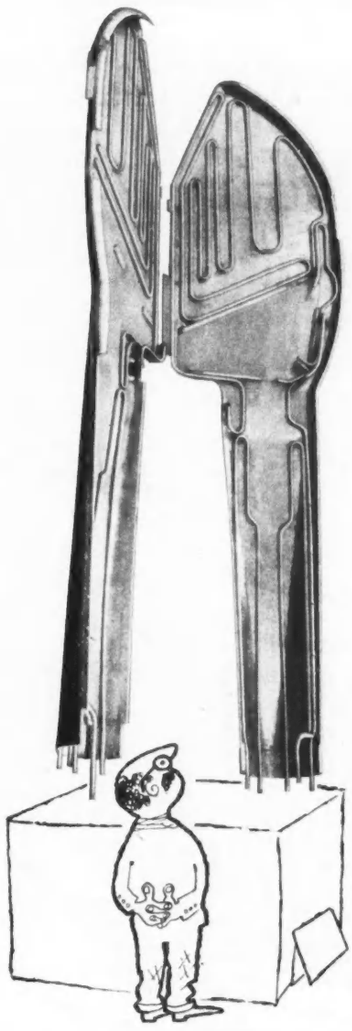

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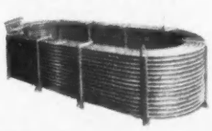

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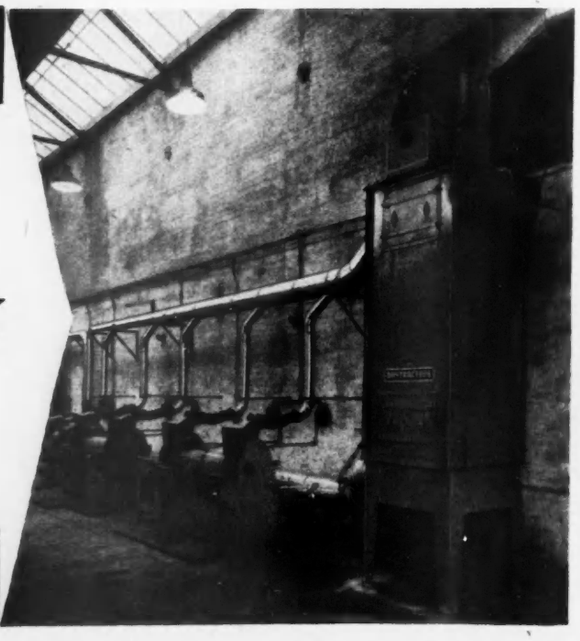

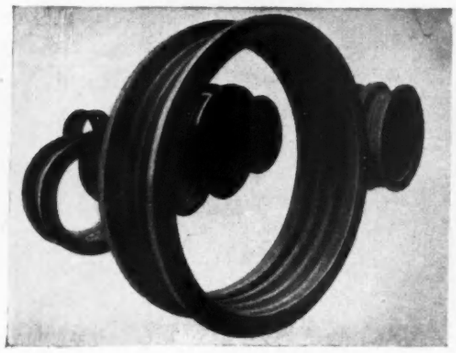

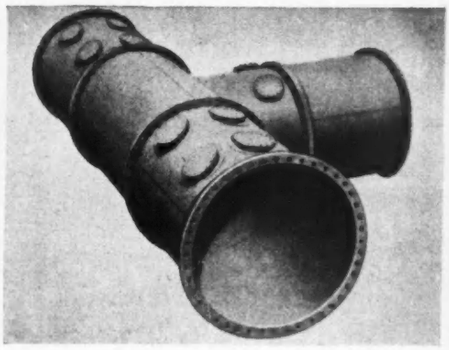

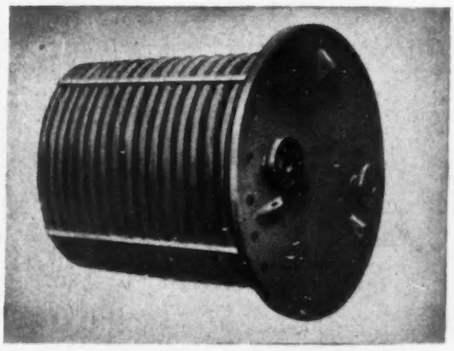

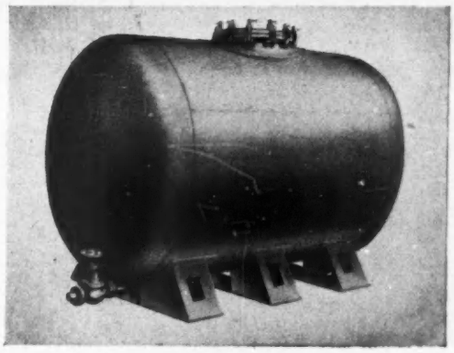

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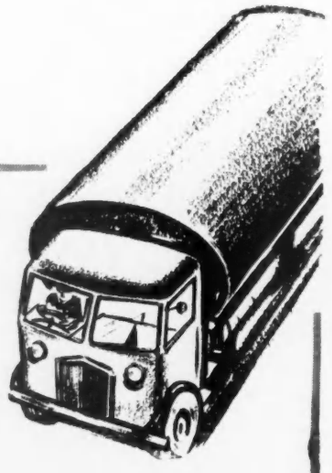

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Warner Electric Brakes and Clutches are stepping up production, shrinking costs, reducing operator fatigue and saving time.

They give lightning-fast, yet smooth cushioned stops and starts; cycle, reverse and index at the touch of a button and are remarkably simple and foolproof in use. Operation is positive and easily controlled to produce the exact torque required.

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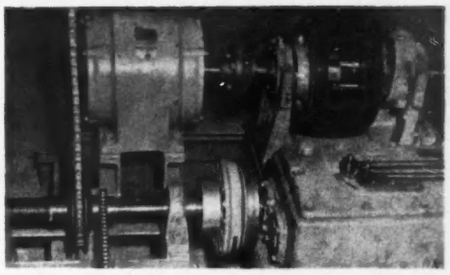
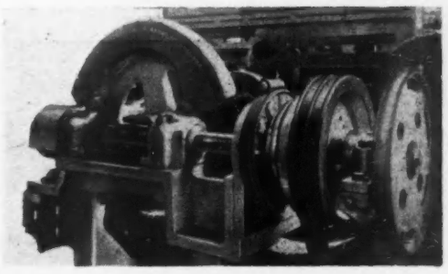
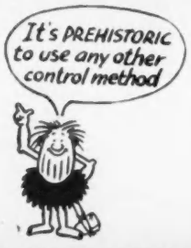


Fully automatic re-winding machine showing a Warner 825 Clutch Coupling incorporated in the main drive.
The General Engineering Company (Radcliffe) Ltd., Radcliffe.



A Warner 1000 Clutch in the main drive of this heavy matting loom provides pre-positioned stopping and rapid starting with safety factors hitherto unknown for this class of loom.
Wilson & Longbottom Ltd. of Barnsley.



Our application Engineering Division is ready to advise at the design stage of new developments or on the conversion of existing machinery. Take action NOW.

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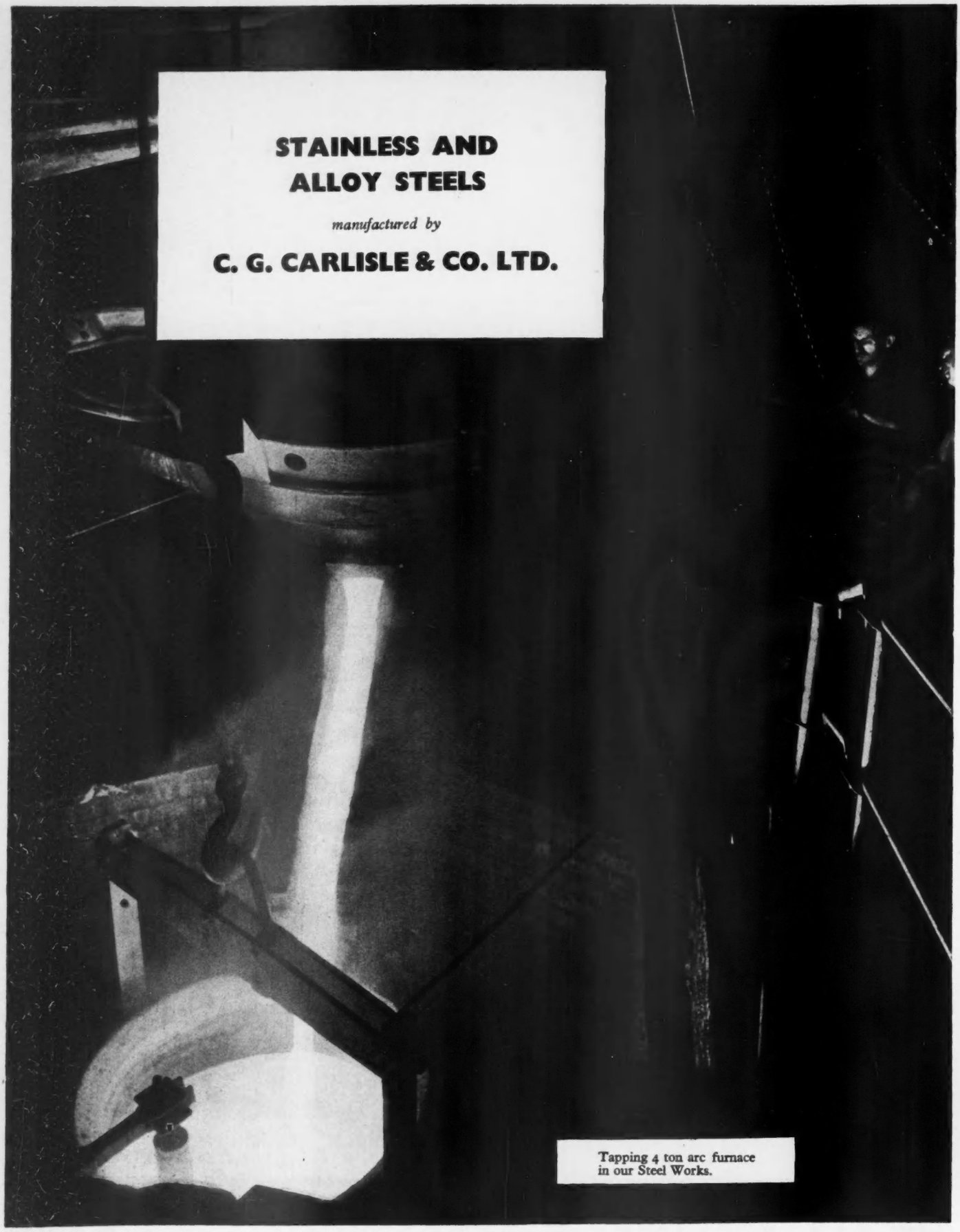

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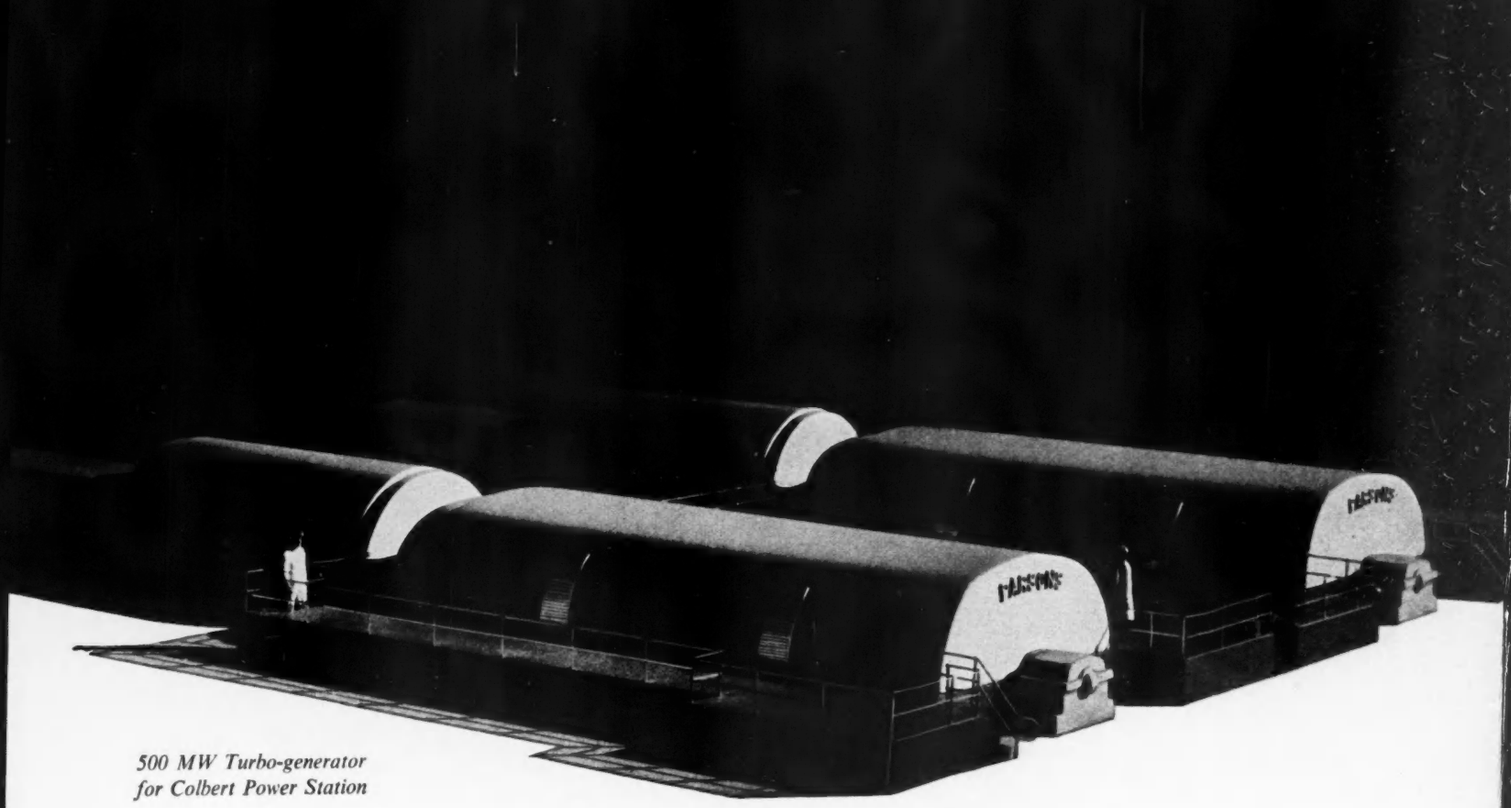

500 MW Turbo-generator for Colbert Power Station

PARSONS turbo-generators for USA

AS long ago as 1912 THE PARSONS COMPANY installed a 25 MW turbo-generator in the Commonwealth Edison Company's Fisk Street Power Station, Chicago. This was the largest and most efficient set in the world at that time. It was so reliable that it became known to the station staff as "Old Reliability".

In 1923 PARSONS installed a 50 MW turbo-generator for the same company at Crawford Avenue Power Station, Chicago. On the reputation of "Old Reliability" no guarantee was required in respect of steam consumption on this new machine.

Now PARSONS are to construct a 500 MW turbo-generator for Tennessee Valley Authority, Colbert Power Station.

One of the largest in the world it is a cross-compound machine with two lines of turbines, each driving a hydrogen and liquid cooled 250 MW generator, ·9 P.F., 24,000 volts, 60 cycles, at 3,600 r.p.m. Steam conditions are: 2,400 lb./sq. in. pressure at 1050°F. with reheating to 1000°F.

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*Silastomer silicone rubber withstands temperature extremes

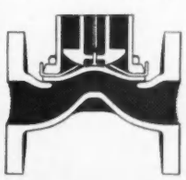
Because of their excellent temperature stability diaphragms of Silastomer silicone rubber are used in many of the various types of valves manufactured by Saunders Valve Co. Ltd. Silastomer will remain serviceable at temperatures as low as −70°C, where other rubbers harden and become brittle, and as high as +250°C, where organic rubbers char and decompose. Silastomer is also resistant to a wide range of chemicals.

Apart from their use as valve diaphragms Silastomer silicone rubbers have many applications as seals and gaskets which must remain durably resilient at elevated temperatures. Grades are available to resist petrol, lubricating and hydraulic oils. Silastomer is also used in paste form as a high temperature caulking and sealing compound and can be coated on to glasscloth for use as heat resistant sleeving, ducting and diaphragms.

The photograph shows one of the many types of Saunders Valves in use in industry.

BY COURTESY OF SAUNDERS VALVE CO. LTD.

The sectional view shows the resilient diaphragm in the Saunders Valve. The excellent temperature stability of silicone rubber diaphragms enables these valves to be used for conveying gases and chemicals at extremes of temperature.



• SILASTOMER IS A REGISTERED TRADEMARK OF MIDLAND SILICONES LTD.

Photo by courtesy of Thomas Hedley Co. Ltd.

MS

Silicone motor rewind saves £400

Thomas Hedley & Co. Ltd., at the company's West Thurrock factory, found that one of their motors working in a particularly wet position, on a mixing tank used in the manufacture of synthetic detergents, broke down at average intervals of 6 months. Rewinds were tried in Class A insulation (costing £30 each time), and in Class B insulation with extra varnish dips to give additional protection against moisture – both without success. Finally they tried a silicone rewind. This was nearly seven years ago and the motor has been operating since without failure, thus saving approximately £400 in rewind costs. In addition losses in production time due to motor failure have been eliminated.

MS silicones strengthen the weak link in all forms of electrical equipment – its insulation. With silicone-insulated motors the risk of breakdown through insulation failure is very greatly reduced. Have your most troublesome motors rewound with silicone insulation. Write to Midland Silicones for names of rewinders with experience in using silicone insulation.

MS

Antifoam kills foam –boosts output

Kill foam and increase the productive capacity of machine tools with a highly efficient MS silicone defoamer. The water and oil coolants used in the heavy-duty grinders shown in the photograph foamed so badly that it was necessary to shut the machine down for 15 minutes of every hour just to clear foam away. Conventional foam inhibitors were partially effective, but reduced the efficiency of the coolant.

A silicone antifoam agent was added to the coolant and foam vanished immediately – "like a punctured balloon" – and hourly grinder output increased 25%.

MS silicone defoamers are effective in low concentrations making them most economical in use. They will remain stable for long periods in either hot or cold storage conditions.

There is an MS silicone antifoam agent in the form of a compound, fluid or emulsion to deal with your particular foaming problem.

First in British Silicones

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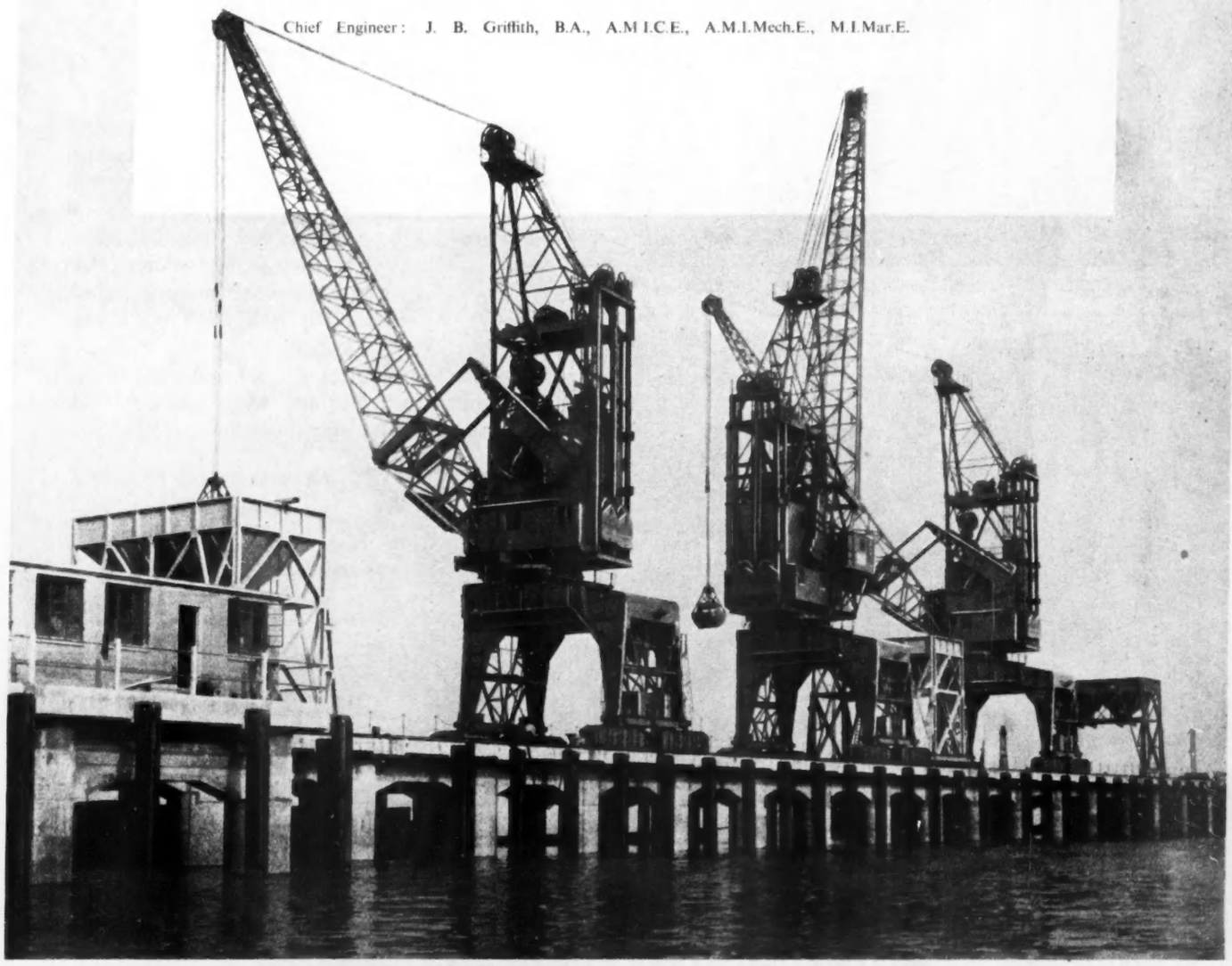

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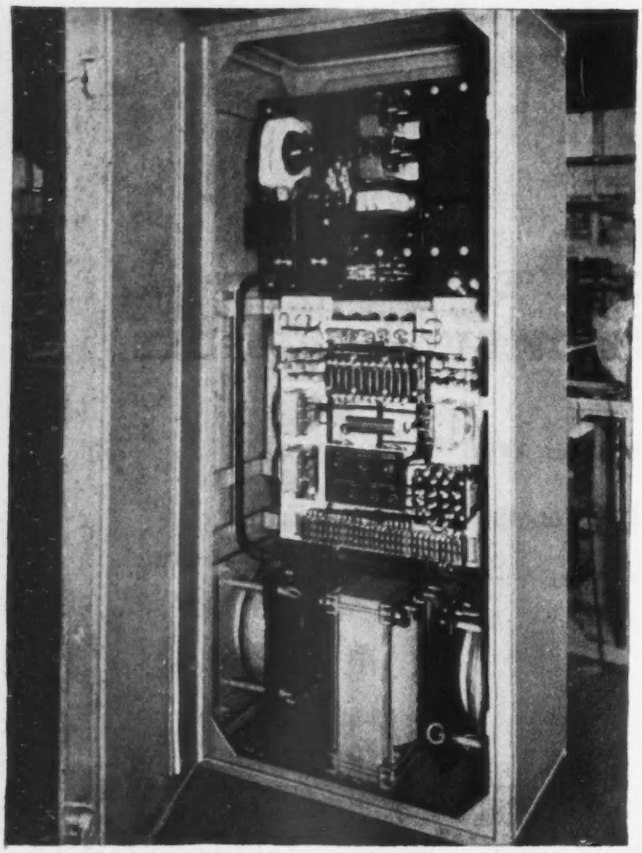

The Fluxetter control cubicle—for a 200 hp. motor speed control.

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"Fluxetter" is the Metropolitan-Vickers trade name for their Flux Resetting Magnetic amplifier which responds to applied signals in approximately 1/100 second on a 50 cycle supply. The principal application to date is for electronic Ward Leonard motor speed control. Such controls are simpler, less expensive, and of faster response with the Fluxetter; "hunting" is more easily eliminated and higher accuracies can be obtained.

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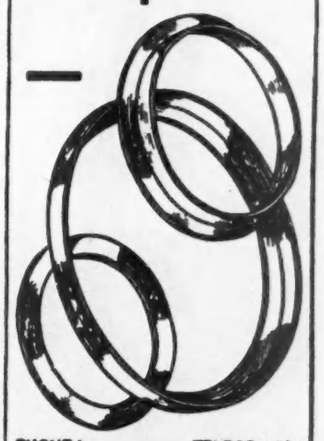

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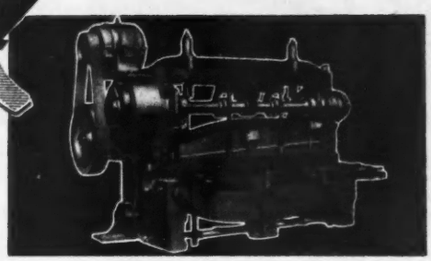

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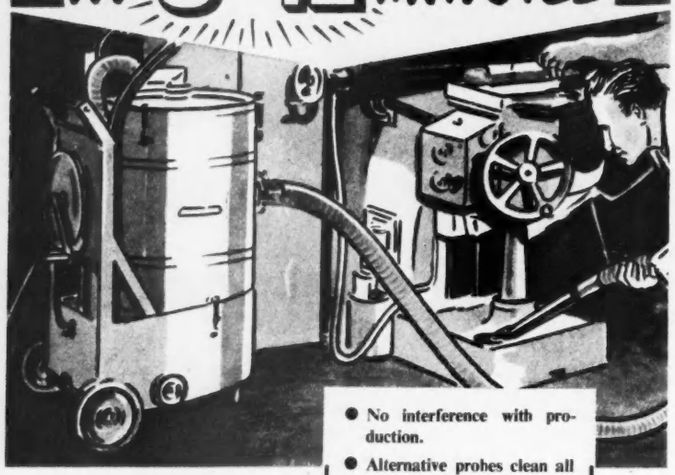

- No interference with production.
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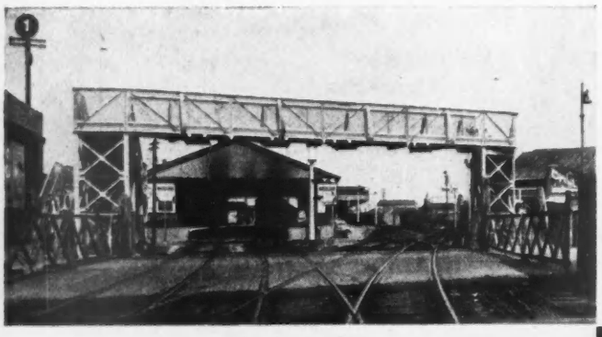
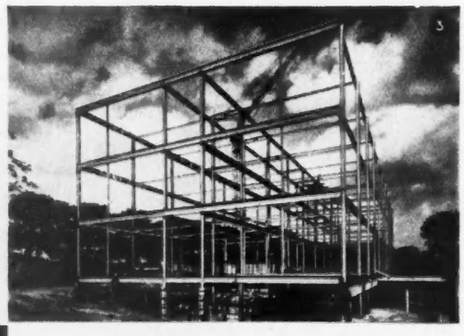


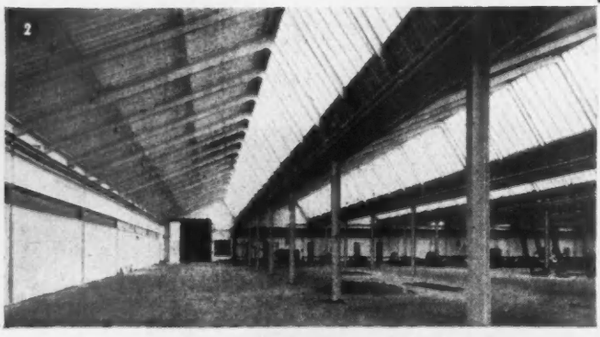
1 Footbridge for Level Crossing in Grimsby.

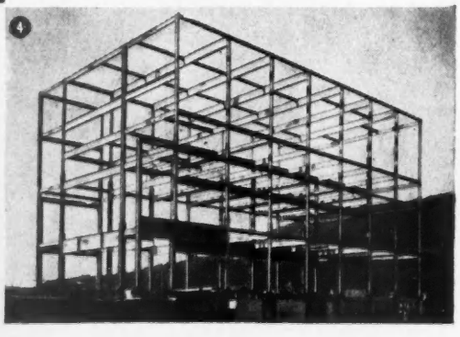
2 Interior view of factory for Messrs. Brook Motors Ltd., Barnsley.



3 Sowerby Bridge Secondary School.

4 Control Room, Services and Welfare Block, Elland Power Station.





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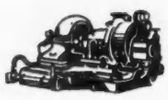

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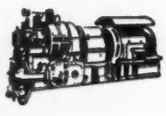

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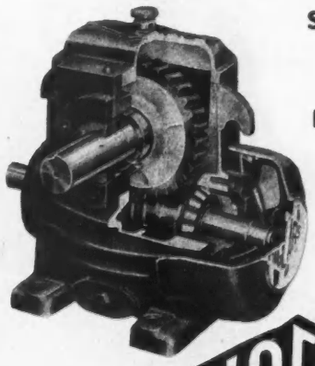

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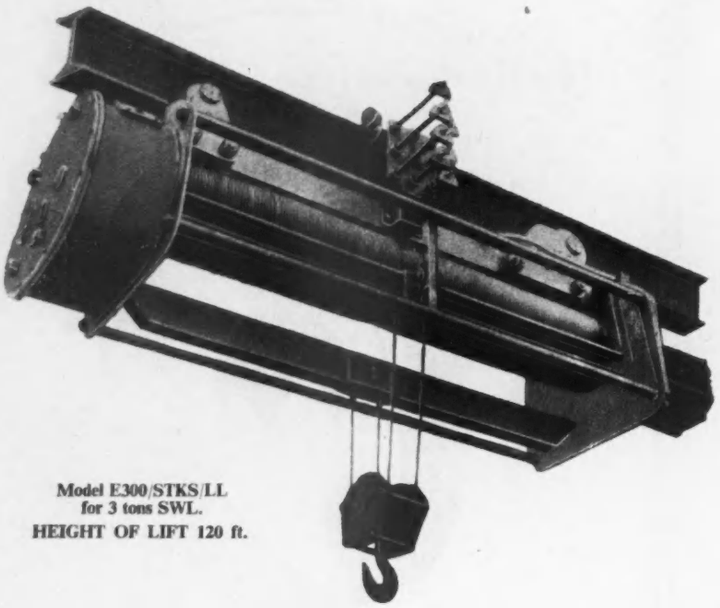

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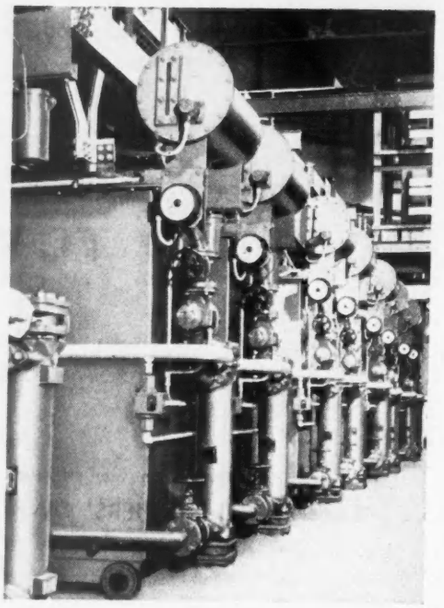

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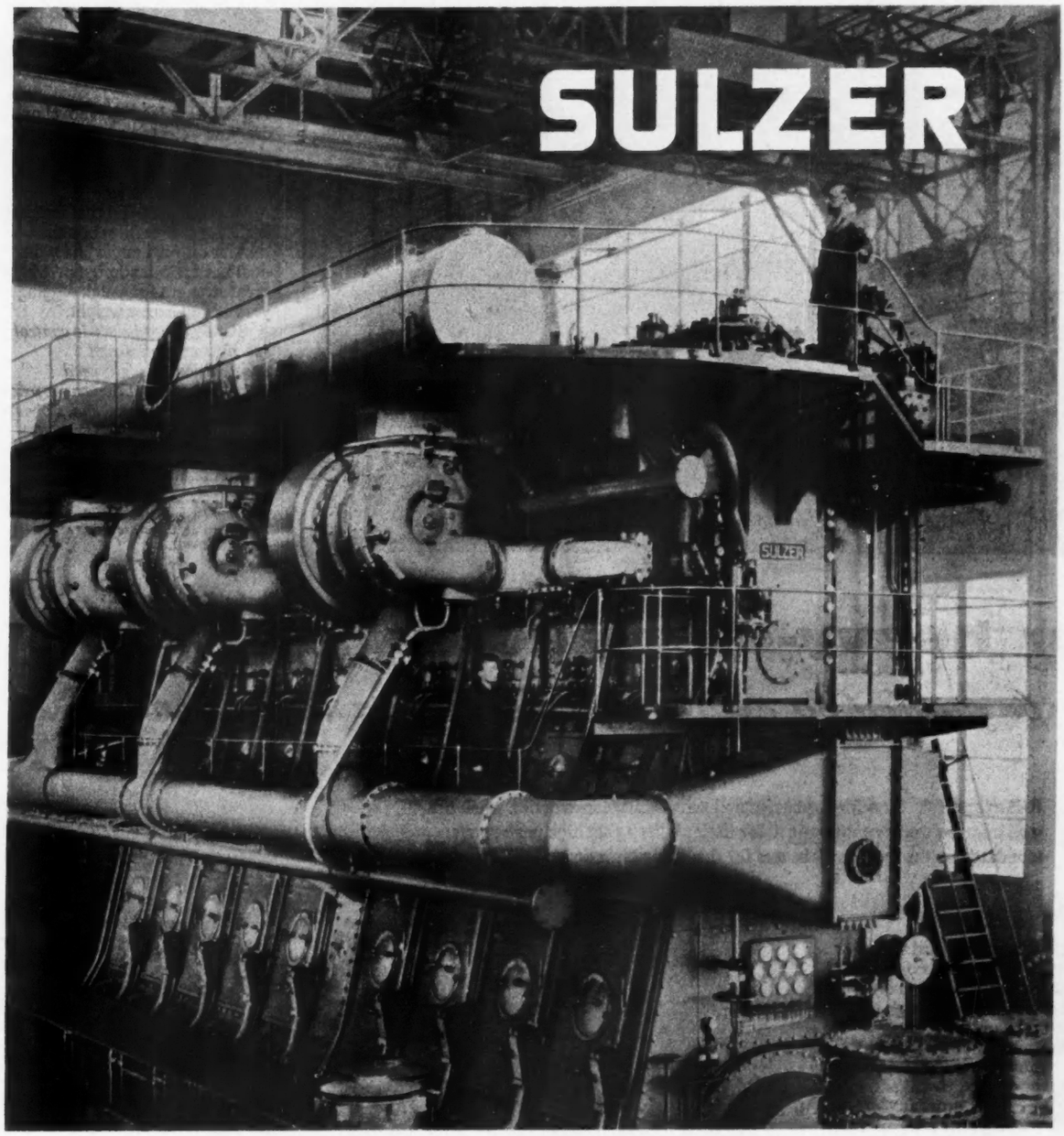

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M/6

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Modern front-end that features exclusive two-section boom, tubular dipper handle and twin dual hoist. Boom design provides great strength for tough digging yet without excess weight.

Ward-Leonard electric control speeds acceleration and deceleration for high speed co-ordinated operation and provides extra torque when needed. Powerful main machinery and easy control for favourable cycle times.

110-RB Ward-Leonard electric shovel in a quarry excavating limestone after blasting. (Belgium)

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R-B excavators for mines, quarries and heavy-duty construction work are well known throughout the world for their ability to set high performance standards on the toughest jobs and for their long term dependability.

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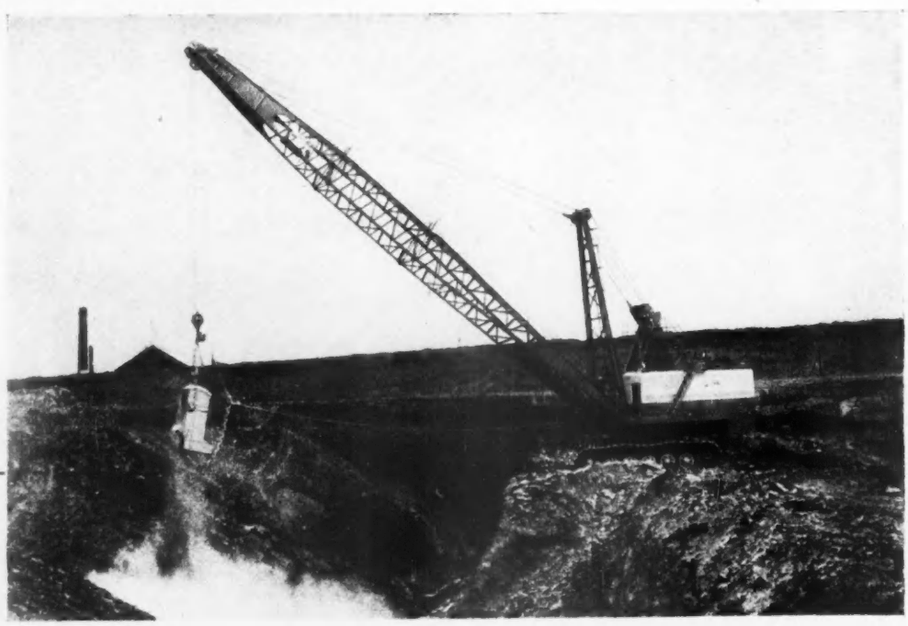
Unique among heavy-duty machines the 110-RB and 150-RB excavators are readily convertible to either shovel or dragline. Lattice-type steel boom is of welded construction providing great strength without excess weight, an outstanding advantage on long-range dragline operations.

Ward-Leonard electric control with independent motor powering of hoist and drag functions.



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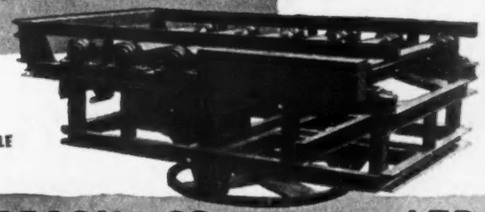

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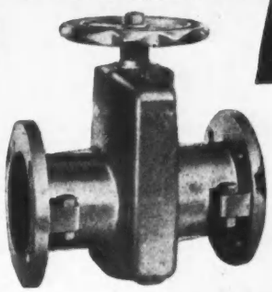

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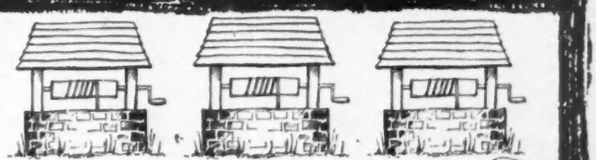

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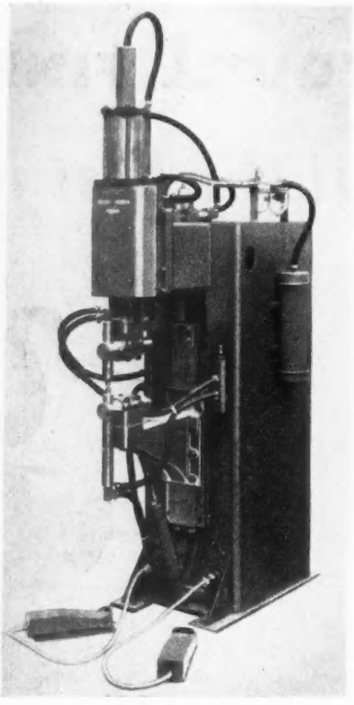

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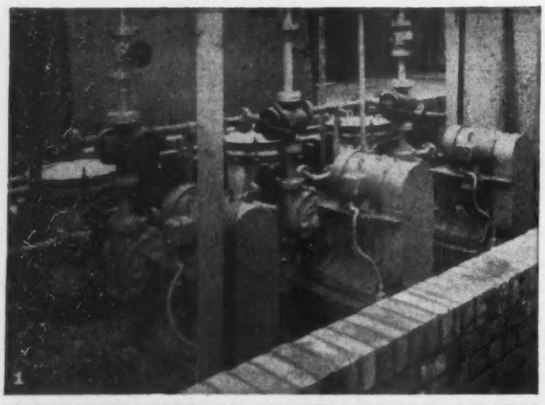

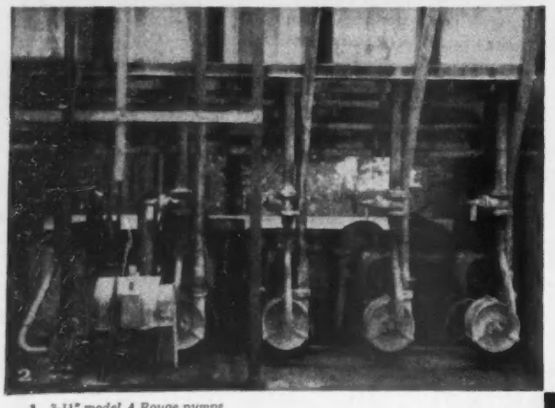

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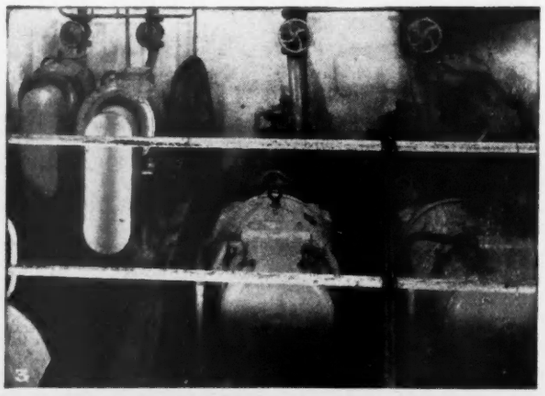

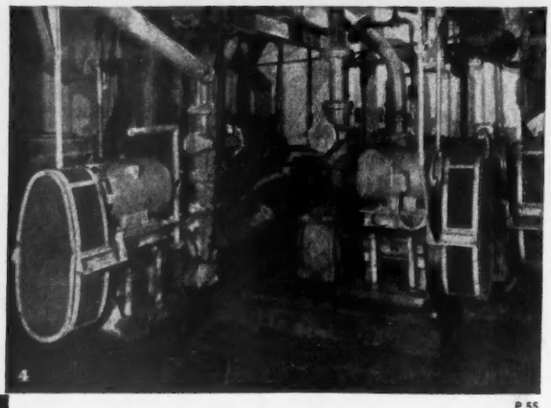

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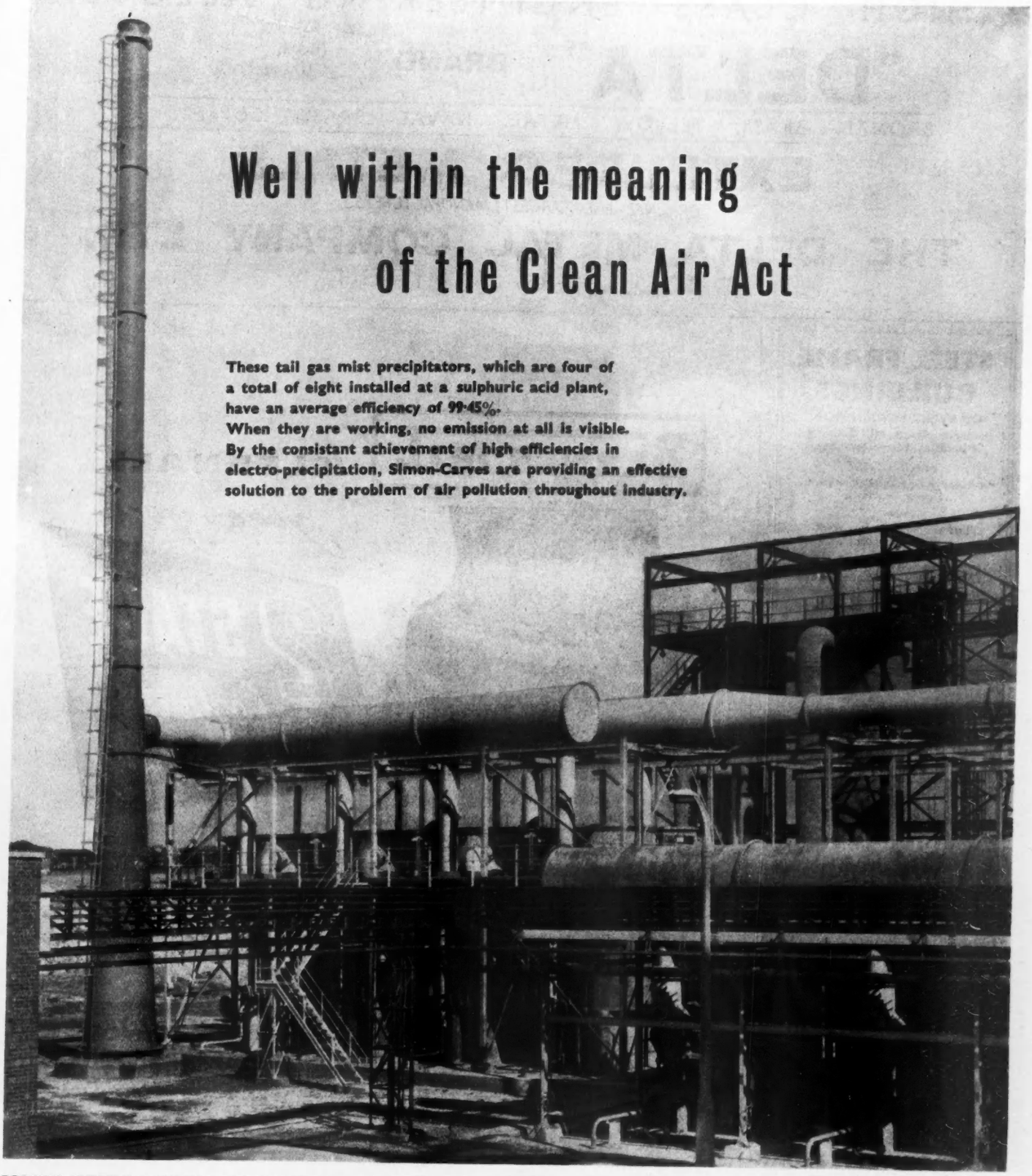

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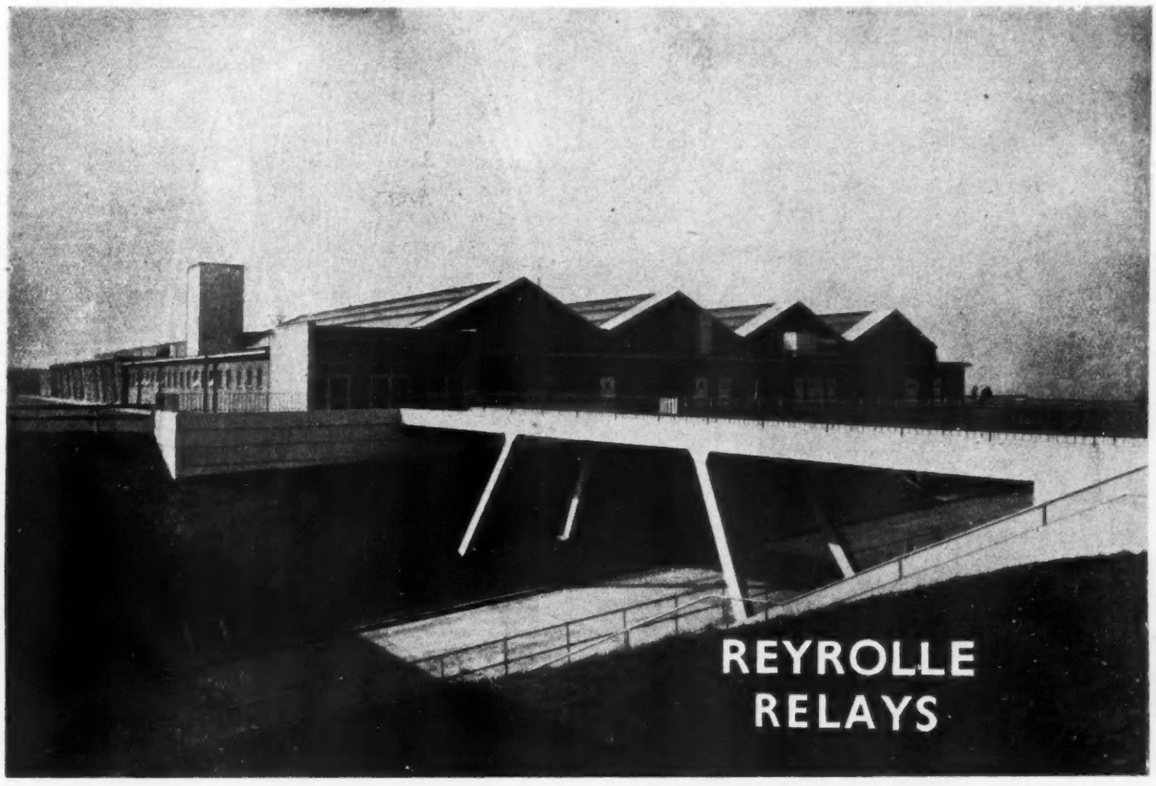

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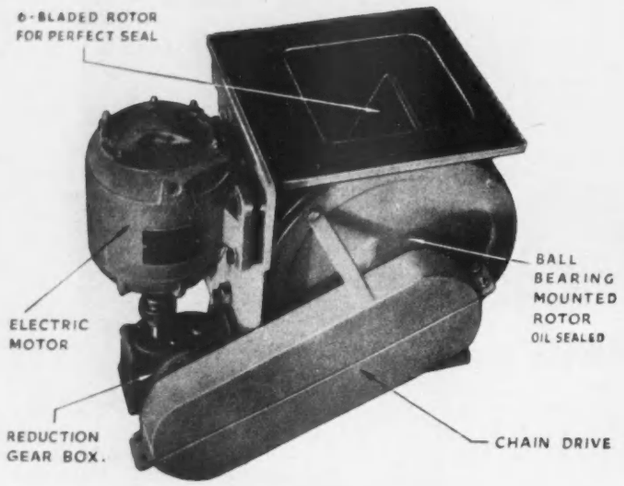

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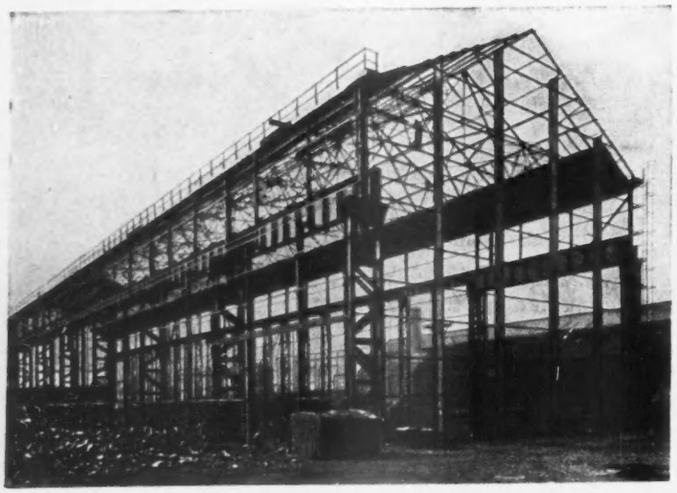

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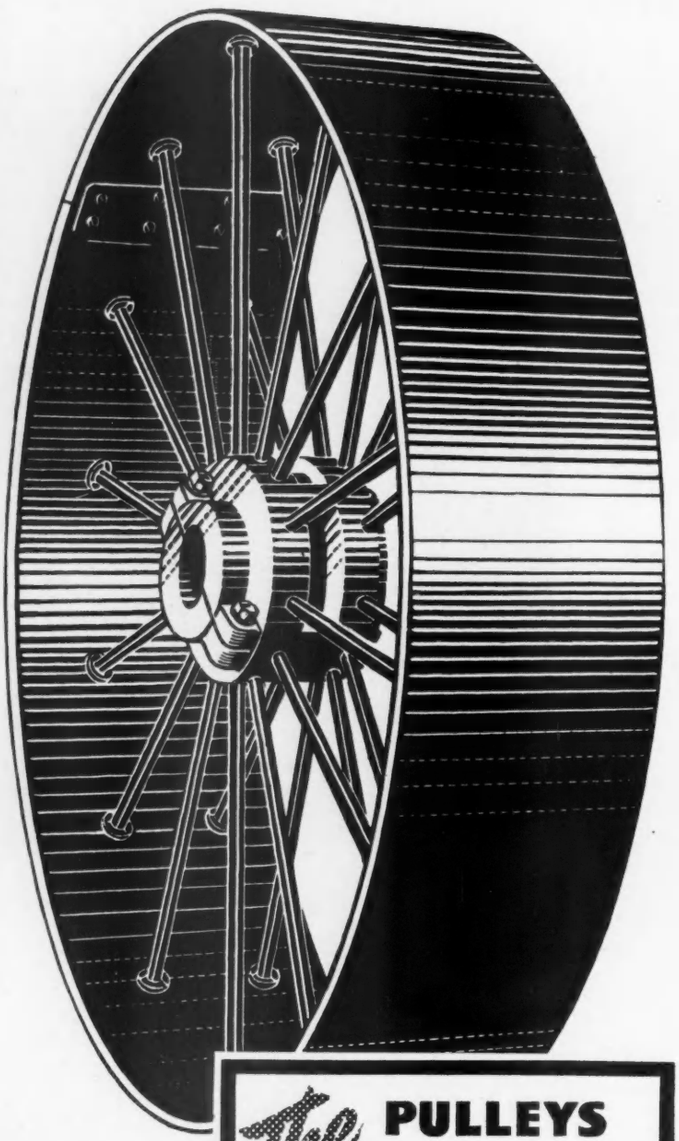

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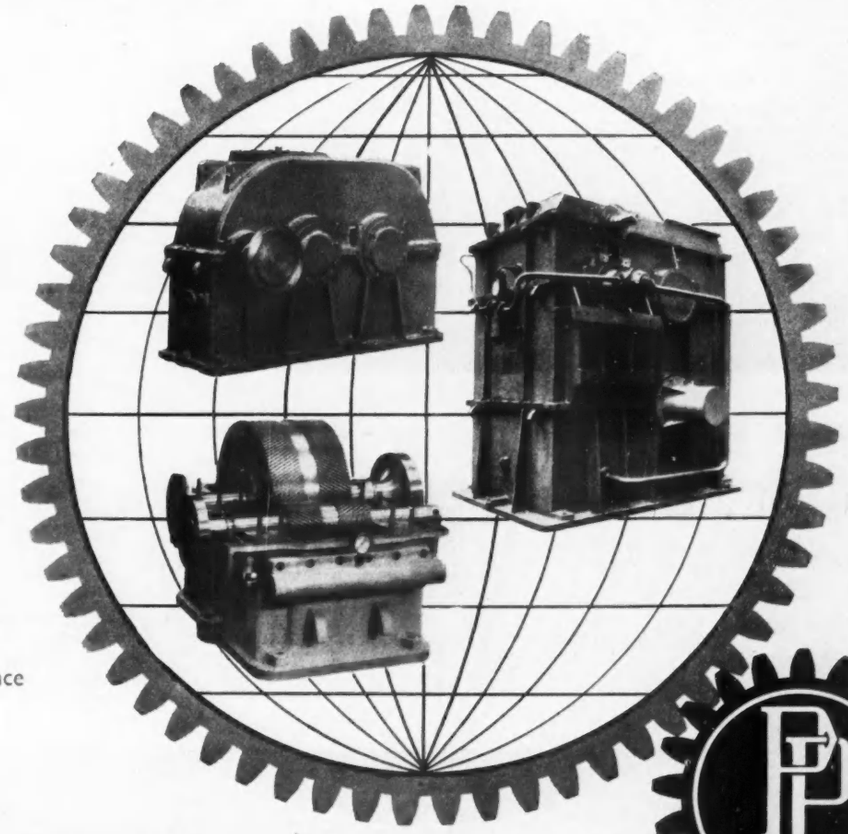

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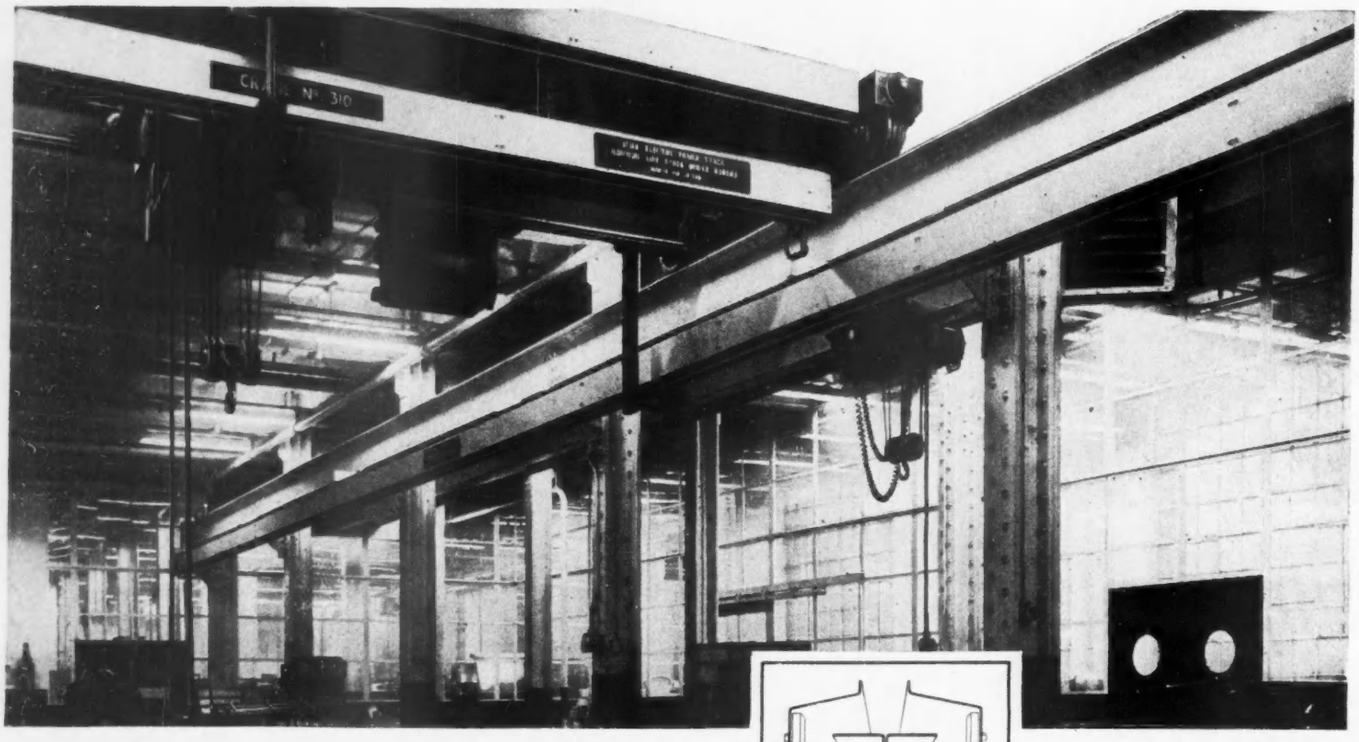

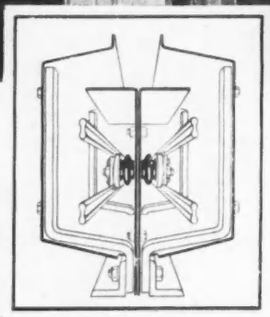

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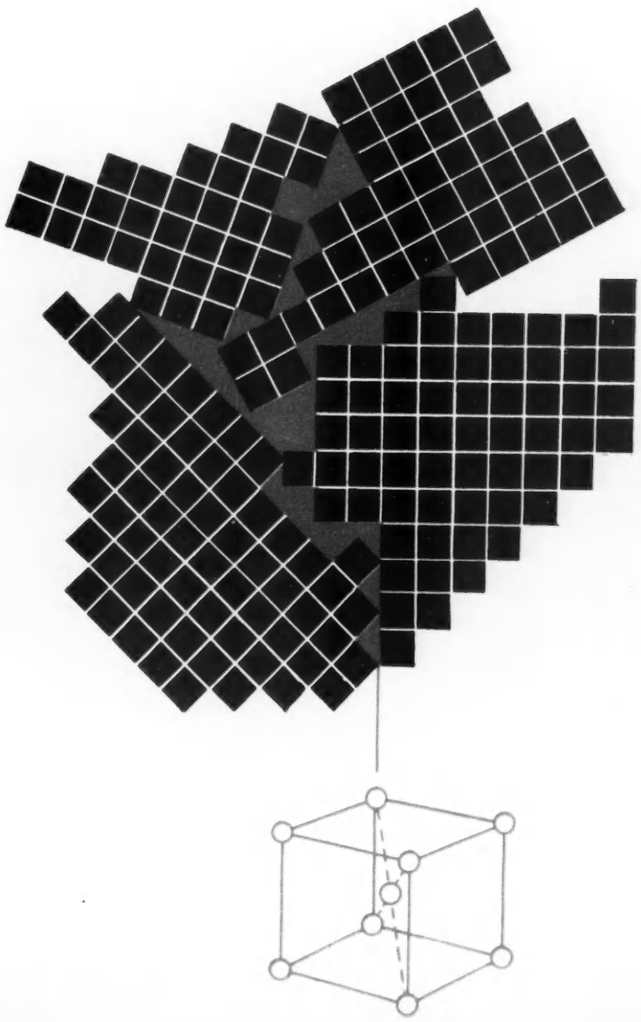
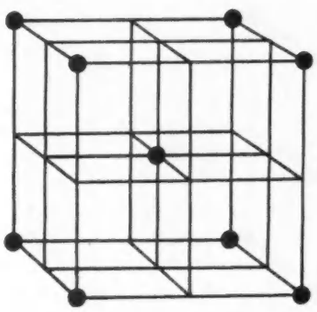
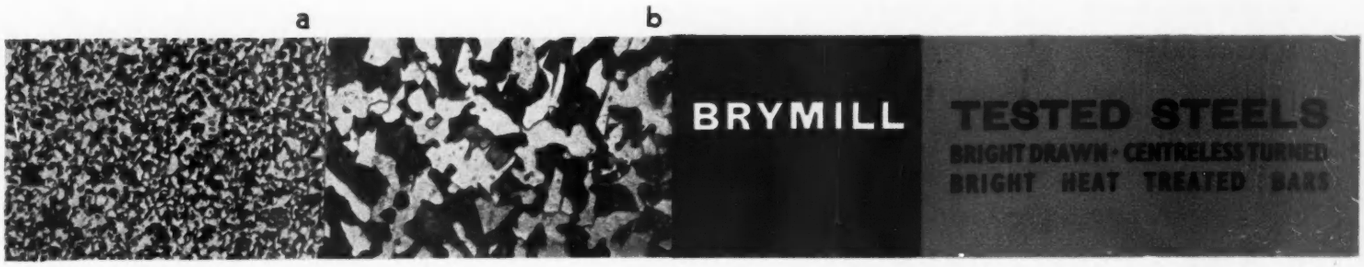




a b



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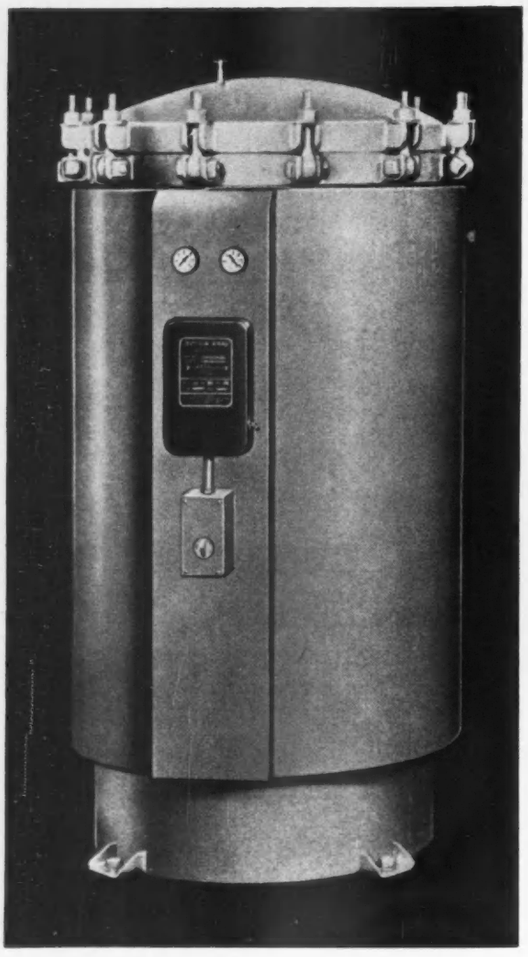

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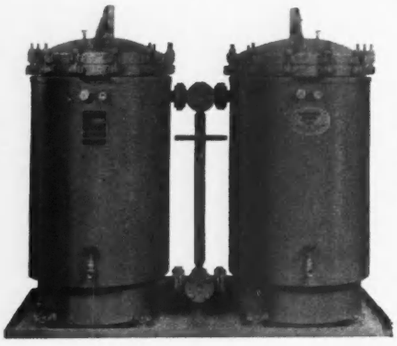

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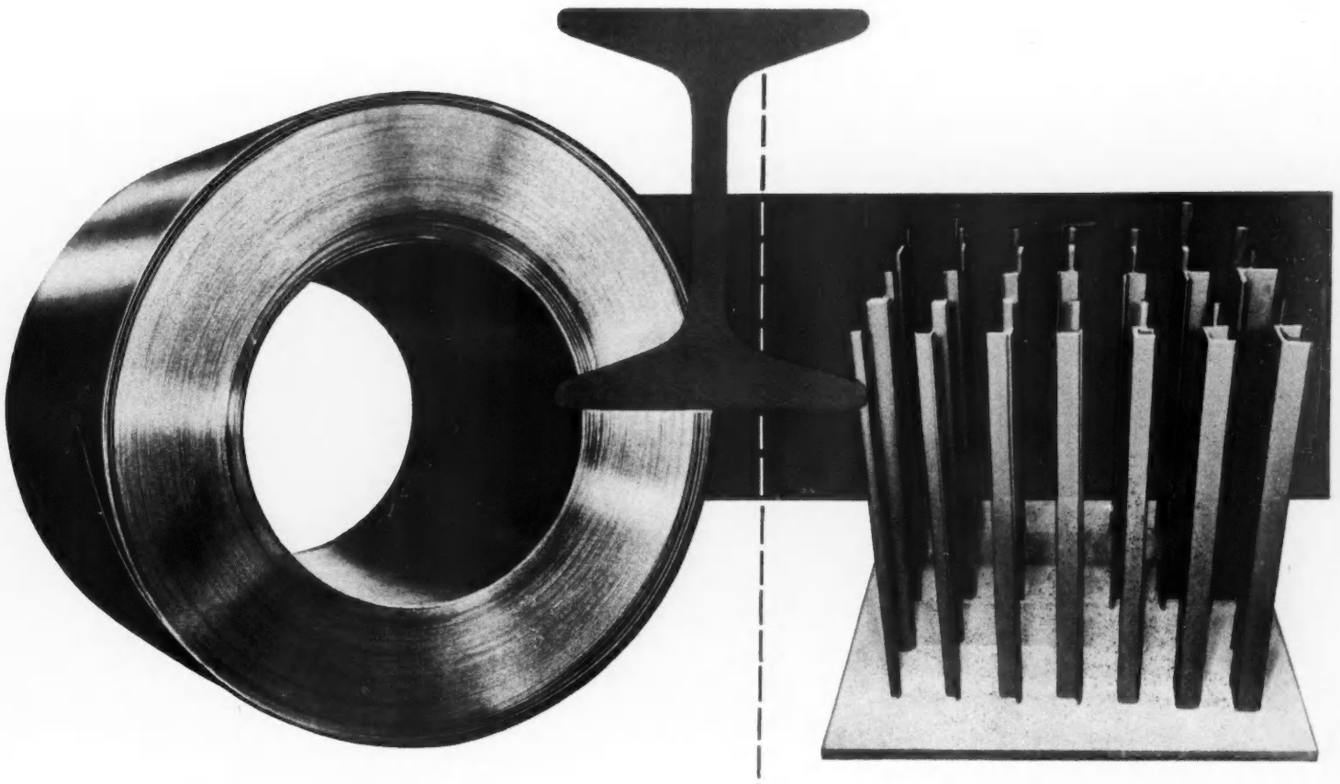

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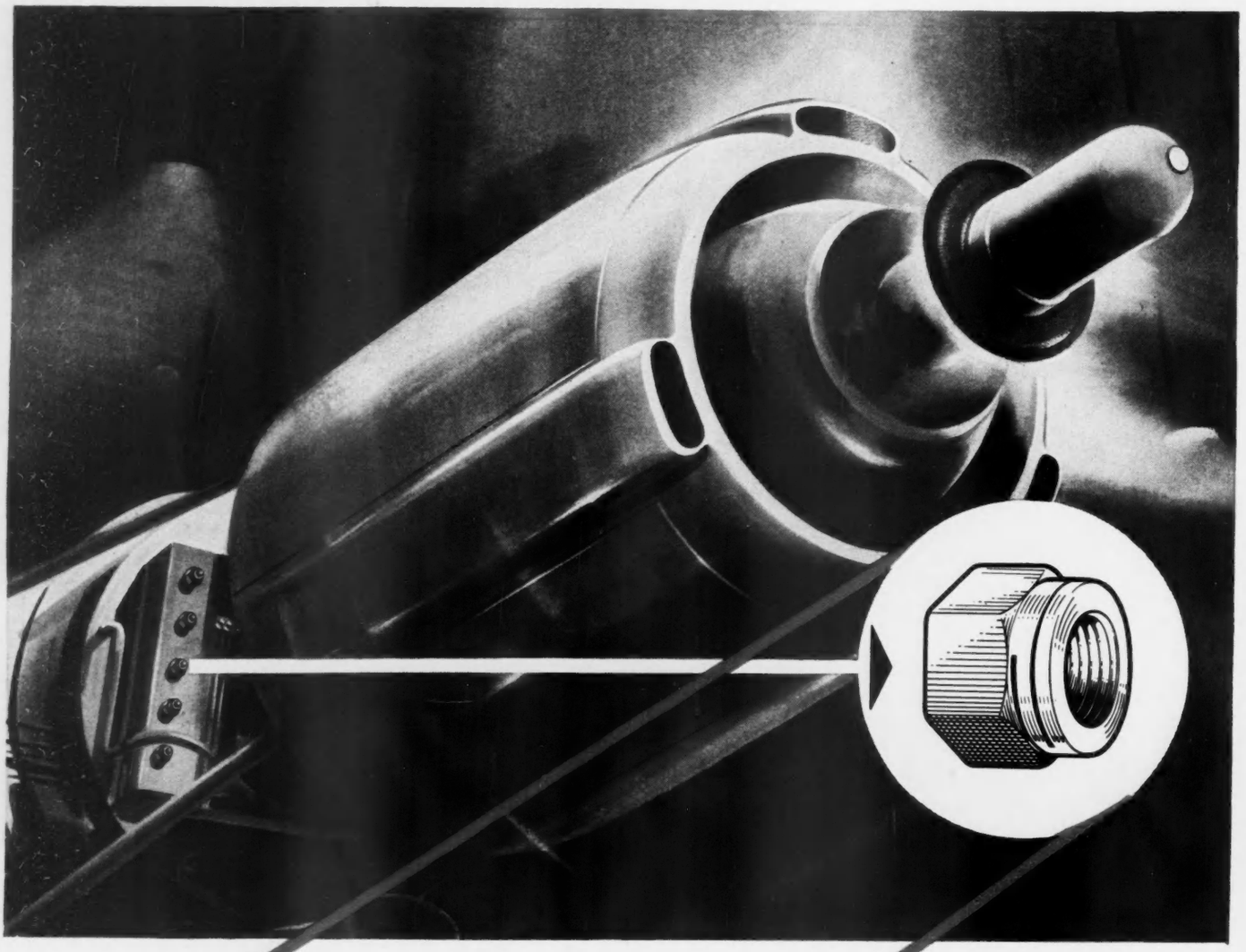

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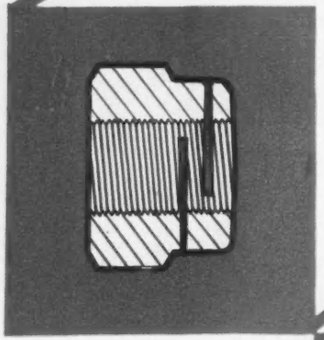

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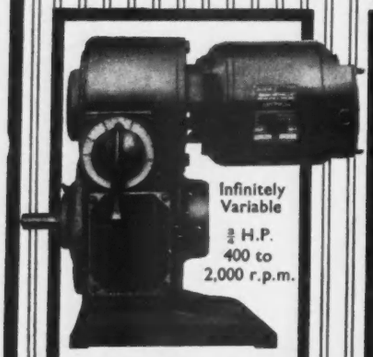

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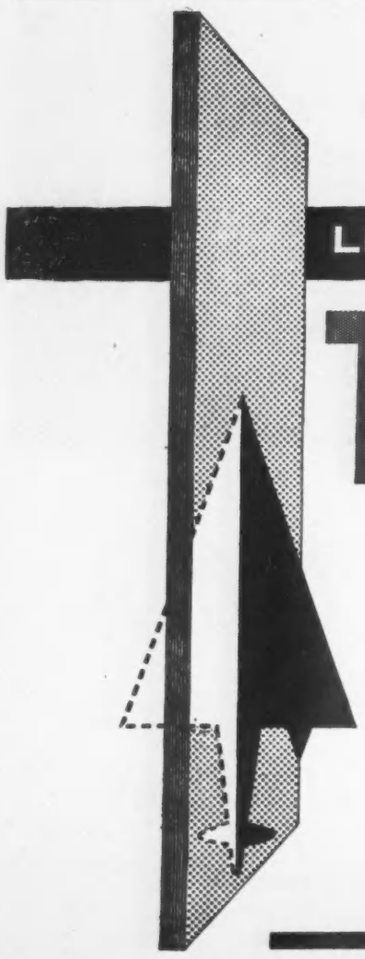

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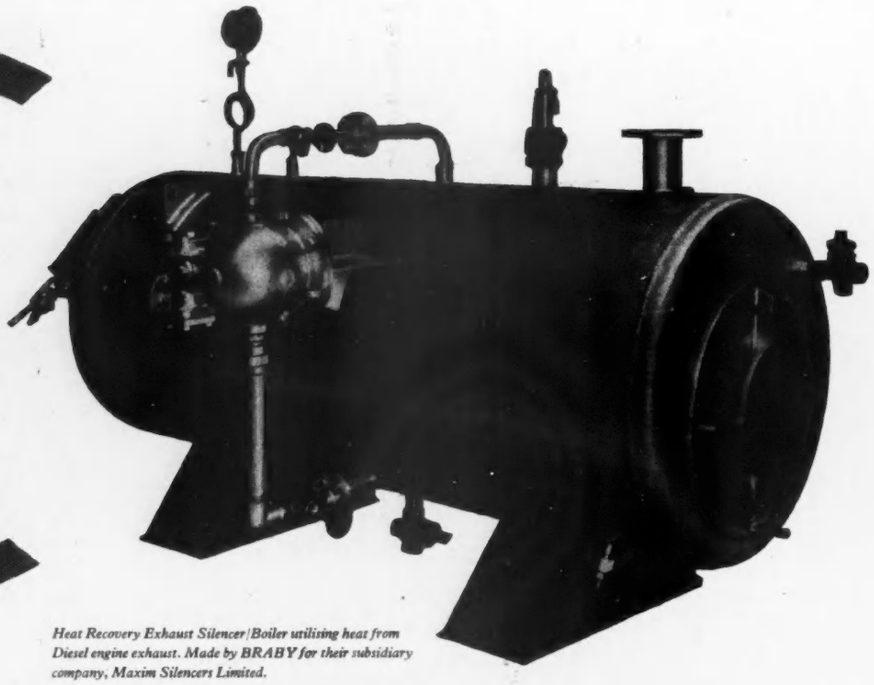
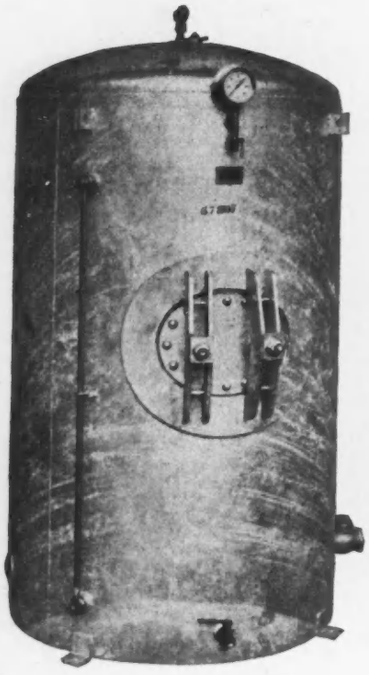
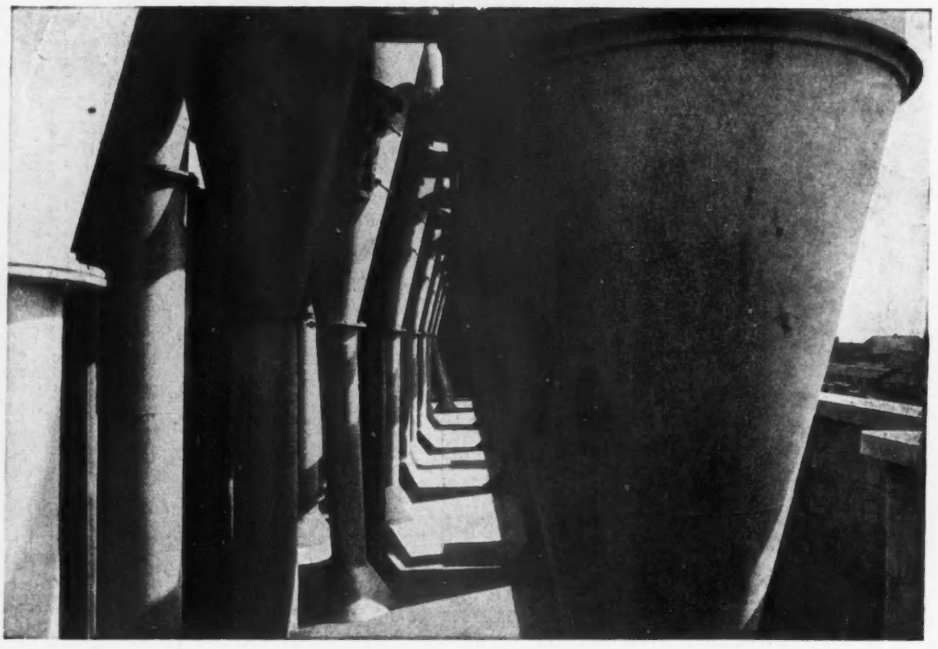


Heat Recovery Exhaust Silencer/Boiler utilising heat from Diesel engine exhaust. Made by BRABY for their subsidiary company, Maxim Silencers Limited.



Pressure Cylinder supplied to Mono Pumps Limited.



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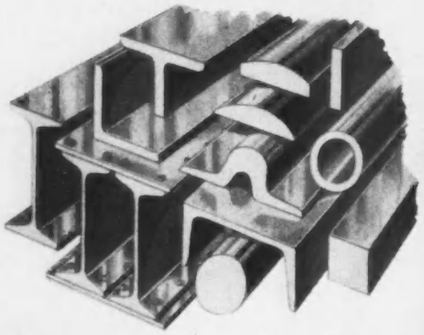

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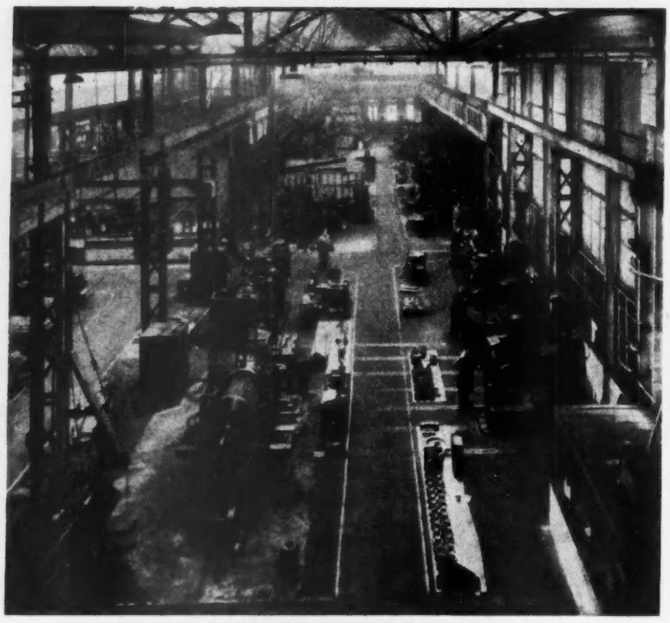

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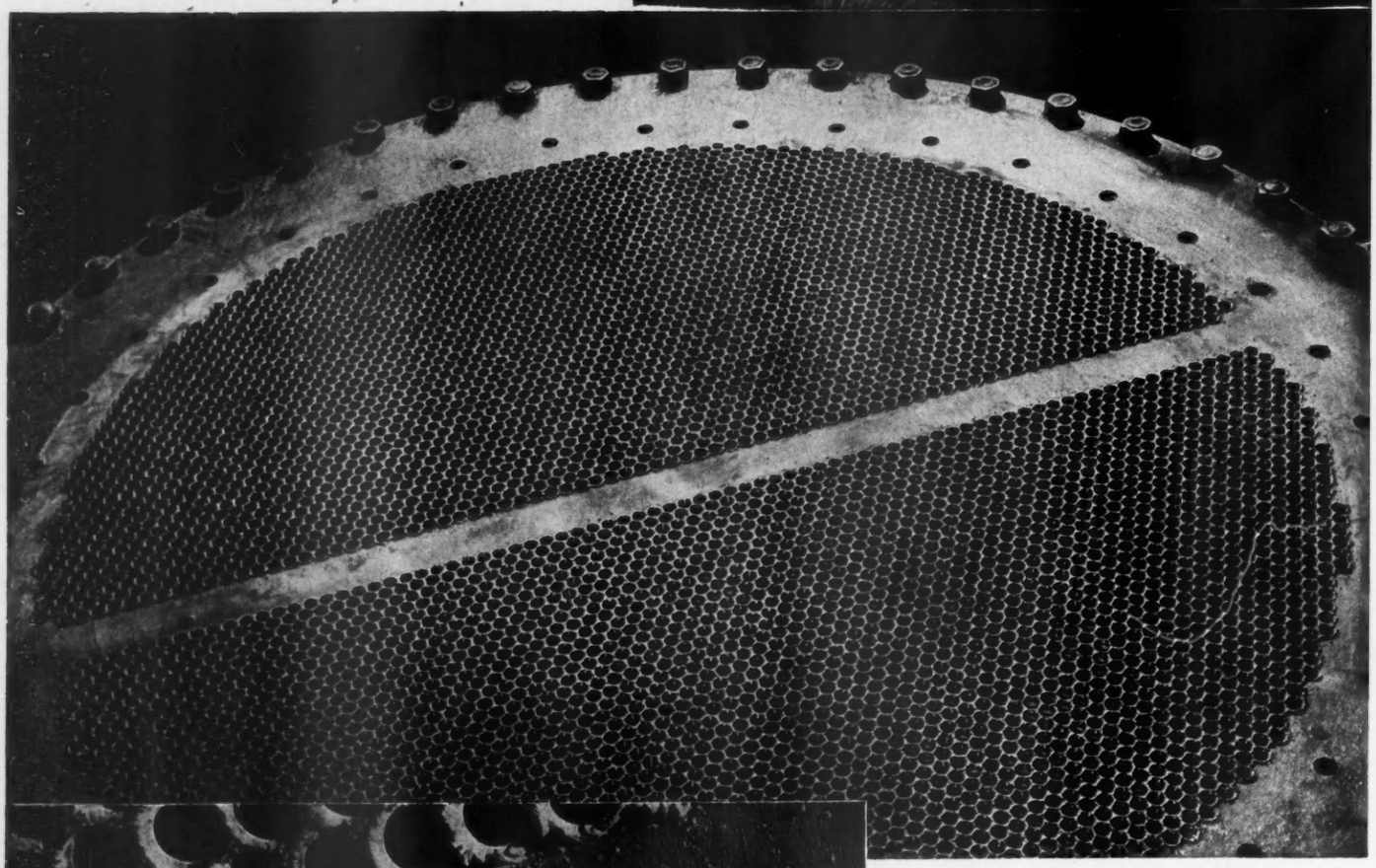

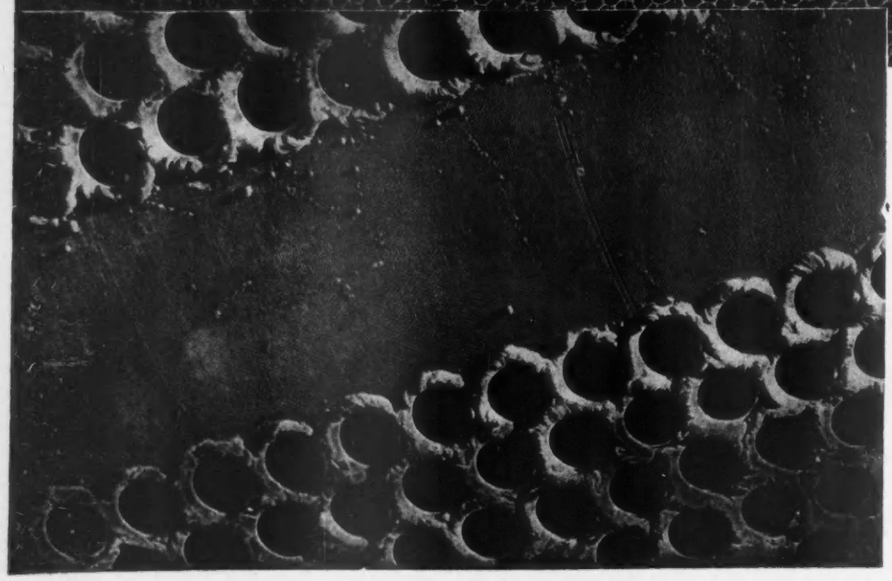

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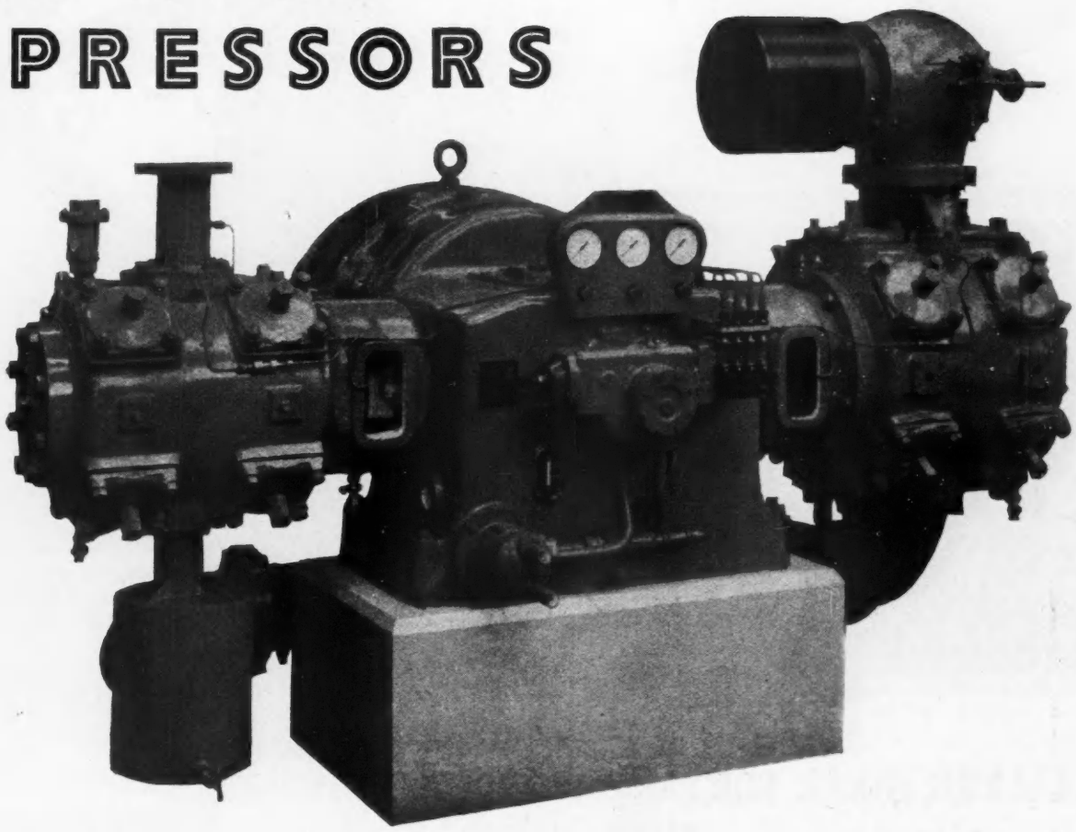

The long established high quality of Alley Compressors is combined in these machines with the known advantages of the horizontally-opposed design.

COMPACTNESS: Intercooler lies below motor. Motor is built on.

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Can be installed on a minimum foundation—even on an upper floor.

The unit is complete—intercooler and oilcooler incorporated—ready for bolting down.

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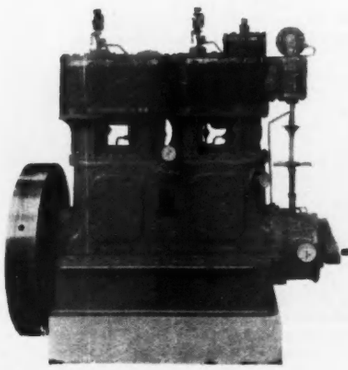

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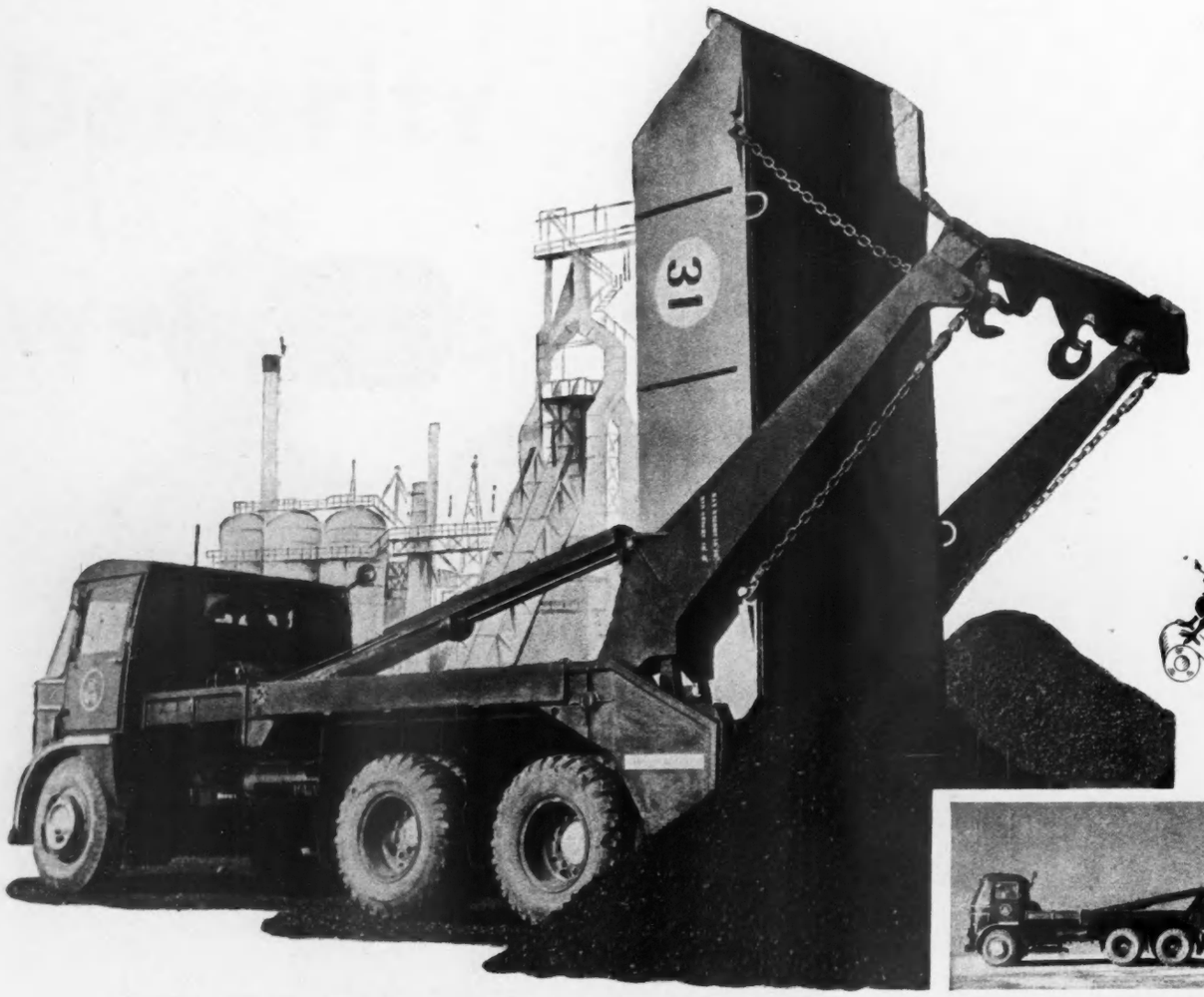
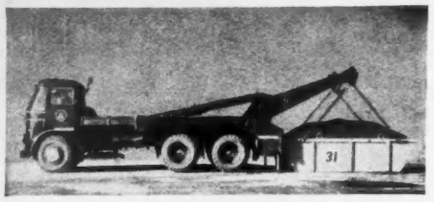
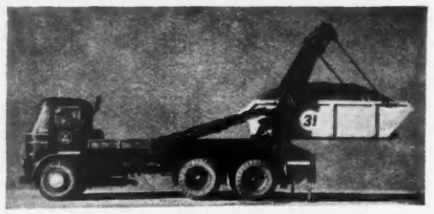


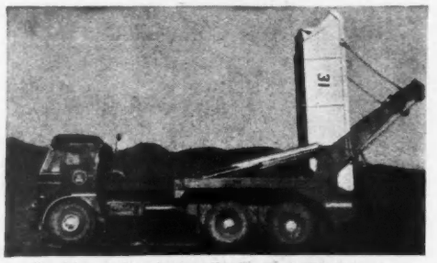


Rear independent hydraulic stabilizer jacks down. Load to be raised to Unit Deck.



Showing load being raised by retraction of hydraulically operated lifting arm rams.

Hydraulically operated rams fully retracted. Load located on Unit Deck. Jacks retracted.



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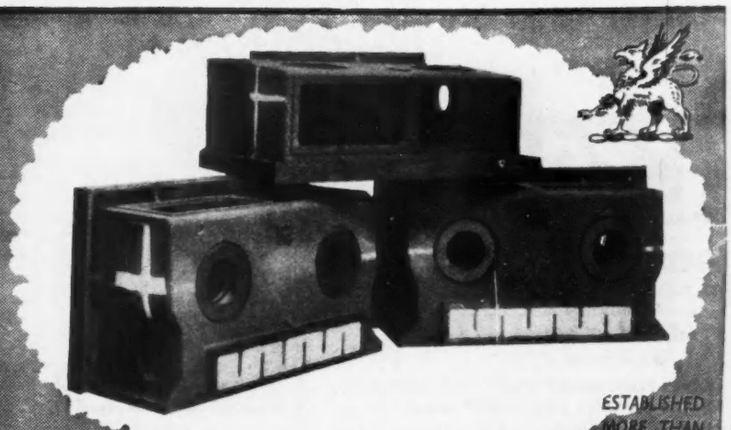

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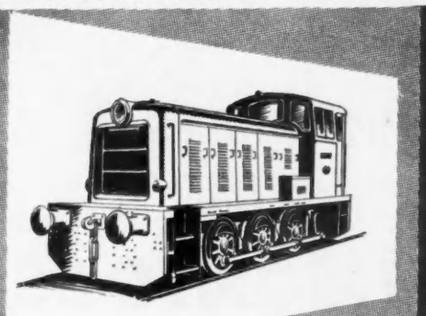

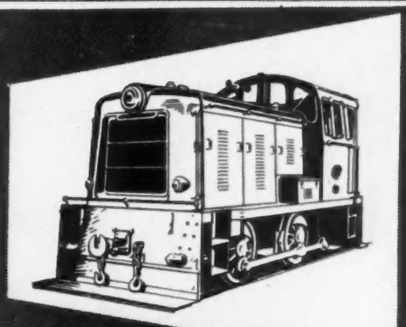

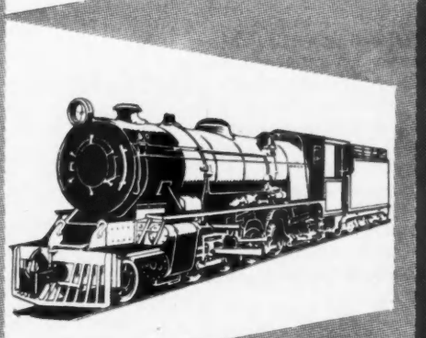

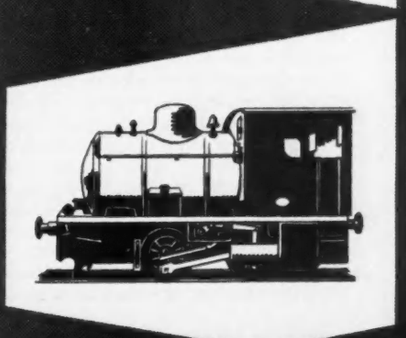

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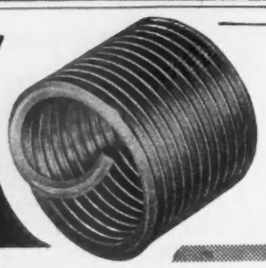

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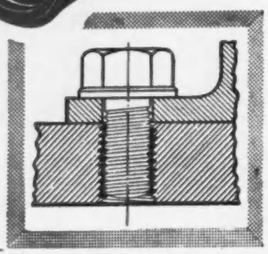

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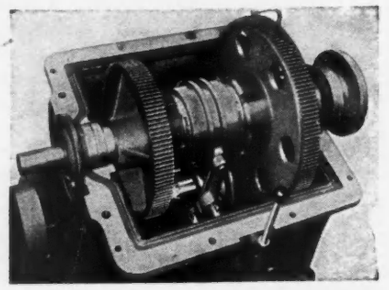

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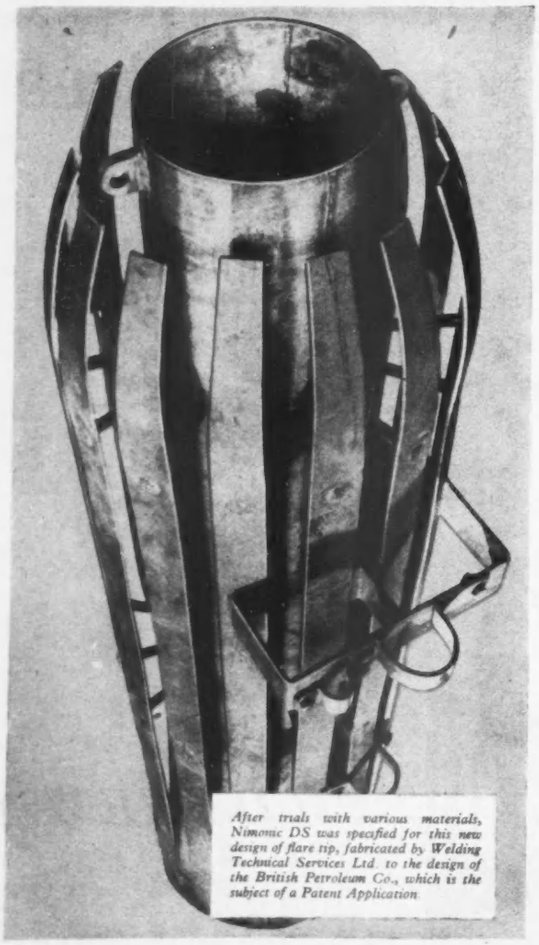

After trials with various materials, Nimonic DS was specified for this new design of flare tip, fabricated by Welding Technical Services Ltd. to the design of the British Petroleum Co., which is the subject of a Patent Application.

AT HIGH TEMPERATURES . . .

NIMONIC DS

The flare stack is one of the items of plant that the oil refinery engineer would like to fit and forget. Unfortunately, the severe conditions at the tip where waste gases are burned present considerable difficulties which put a limit on life. The temperature of the flare tip varies with the volume of gases exhausted, their calorific value and the temperature and velocity of the prevailing wind. These conditions are aggravated by the tendency of the flame to sweep downwards around the outer lee side of the tip. From the fact that even from the ground it can be seen to be glowing red, it is believed that at times the temperature may reach 800° C. As a result of trials with various materials at the B.P. Group's Llandarcy refinery, Nimonic DS was selected for a new design of flare tip. This nickel-chromium alloy has good resistance to both oxidizing and reducing atmospheres and retains much of its strength at temperatures up to 960° C.

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THE MACFARLANE ENGINEERING COMPANY LIMITED
NETHERLEE ROAD, CATHCART, GLASGOW. Telephone: Merrylee 2255/6/7.

CLASSIFIED ADVERTISEMENTS

AGENCIES · DIRECTORS · PARTNERSHIPS · SITUATIONS VACANT · EDUCATIONAL PATENTS · BUSINESS OPPORTUNITIES · MISCELLANEOUS · PUBLIC APPOINTMENTS BUSINESSES and PREMISES · TENDERS

AUCTION SALES · FOR HIRE · MACHINERY, etc., WANTED · SITUATIONS WANTED DRAWING AND DESIGN SERVICES · FOR SALE · SUB-CONTRACTING

Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-.

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Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. "Run-on" and "Semi-displayed" advertisements by noon Tuesday for publication on Friday same week. "Displayed" and "Illustrated" advertisements by noon Friday for publication on following Friday. All advertisements three days earlier if proofs are required.

***Advertisements for publication should be addressed to:*—Classified Advertisement Dept., "The Engineer", 28 Essex Street, Strand, London, W.C.2.**

Urgent advertisements may be telephoned to CENtral 6565

PUBLIC APPOINTMENTS

KUMASI COLLEGE OF TECHNOLOGY

Principal: W. E. DUNCANSON, Ph.D., D.Sc., F.Inst.P., A.M.I.E.E.

HEAD OF THE DEPARTMENT OF MECHANICAL ENGINEERING

Applications are invited for the post of HEAD OF THE DEPARTMENT OF MECHANICAL ENGINEERING. College prepares students for external B.Sc. (Eng.) Degree of London University, for examinations of the professional Institutions and for College Diplomas of approximately H.N.C. standard.

Appointment on contract for 5 years or on pension, but College prepared to arrange continuation of premium payments on policies initiated under F.S.S.U.

Contract salary scale: £2593 by £125 to £2918 per annum, plus professional allowance of £250 per annum plus gratuity payable at end of contract at rate of £12 10s. for each month of satisfactory service. Pensionable and F.S.S.U. salary scale: £2075 by £100 to £2335 per annum, plus a non-pensionable professional allowance of £250 per annum. Entry point according to qualifications and experience.

Children's allowances to a maximum of three at rate of £50 per annum per child up to 10 years and £100 per annum per child over 10 years in full-time education up to 21 years. Annual leave with free return 1st class passages for member of staff, his wife and up to three children under 17 years. Bungalows with basic furniture at moderate rental provided. Income tax low.

Applications (6 copies) to Council for Overseas Colleges, 12, Lincoln's Inn Fields, London, W.C.2, giving age, education, qualifications, experience and names of 3 referees by 11th May, 1959. E5473

UNIVERSITY OF LONDON KING'S COLLEGE

LECTURERS

The College will require, on October 1st, 1959, a LECTURER IN CIVIL ENGINEERING and a LECTURER IN MECHANICAL ENGINEERING. Applicants should have a good Honours Degree, professional experience and preferably some experience of teaching and/or research in the relevant branch of engineering. Salary scale: £900 by £50 p.a. to £1350; then, after review, by £75 p.a. to £1650. A London allowance of £60, family allowances, and F.S.S.U. benefits will also be payable.—Full conditions of appointment and application forms may be obtained from the Registrar, King's College, London, Strand, W.C.2; completed forms must reach him by May 5th, 1959. E5440

UNIVERSITY OF LIVERPOOL

APPOINTMENTS

Applications are invited for the following posts in the Department of Civil Engineering:—

ASSISTANT LECTURER or LECTURER. The salary will be within the range £700–£1650 per annum, according to age, qualifications and experience.

TWO POSTS of DEMONSTRATOR. The initial salary will be within the range £500–£650 per annum, according to qualifications and experience.

Applications, stating age, academic qualifications and experience, together with the names of three referees, should be received as soon as possible by the Registrar, from whom further particulars of the conditions of appointment may be obtained. E5437

QUEEN MARY COLLEGE

UNIVERSITY OF LONDON

LECTURER IN CIVIL ENGINEERING

Applications are invited for the post of LECTURER IN CIVIL ENGINEERING. Practical or research experience is desirable. Salary scale: £900 by £50 to £1350 (efficiency bar): £1425 by £75 to £1650, plus London Allowance of £60, F.S.S.U. participation and family allowance of £50 for each child.

Application forms, obtainable from the Registrar, Queen Mary College, Mile End Road, London, E.1, to be returned by May 22nd. E5482

PUBLIC APPOINTMENTS

CITY OF LIVERPOOL EDUCATION COMMITTEE

CITY COLLEGE OF TECHNOLOGY

BYROM STREET, LIVERPOOL, 3

Principal: S. A. J. PARSONS, B.Sc. (Econ.), M.I.Mech.E., M.I.Prod.E., M.B.I.M.

APPOINTMENTS

Applications are invited from suitably qualified persons for the following appointments (full-time). (Duties to commence as soon as possible.)

(1) HEAD OF DEPARTMENT OF CIVIL, MECHANICAL AND MARINE ENGINEERING

Salary: £1900 by £50 to £2050 per annum, plus 5 per cent. (Burnham Technical Report).

The department also offers Production Engineering (including Sheet Metal Work and Welding) and Metallurgy.

Applicants, who should preferably be mechanical engineers, should possess high academic and professional qualifications, industrial and teaching experience to Degree level is essential. They must also possess organising and administrative ability and be prepared to undertake research. The person appointed will be expected to develop the work of the department with particular reference to the provision of post-graduate courses and research.

(2) SENIOR LECTURER IN PRODUCTION ENGINEERING

Salary: £1350 by £50 to £1550 per annum, plus 5 per cent. (Burnham Technical Report).

Applicants must have had appropriate industrial experience and teaching experience is desirable. They should be able to teach up to the Higher National Certificate and Diploma level. The person appointed would be encouraged to undertake research, and to make contact with industry. He should be capable of leading the Section and assisting in its progress and development under the Head of Department.

This is a Regional College providing courses at the advanced level. It possesses adequate facilities in this specialist field. The intention is to develop Production Engineering studies, particularly in the provision of post-advanced courses and in applied research.

Further particulars and application forms (returnable by 12th May, 1959) may be obtained from H. S. Magnay, M.A., Director of Education, 14, Sir Thomas Street, Liverpool, 1.

THOMAS ALKER,
Town Clerk and Clerk to the Local Education Authority. (J.5609.) E5512

ROYAL NAVAL SCIENTIFIC SERVICE

SENIOR SCIENTIFIC OFFICERS AND SCIENTIFIC OFFICERS

Royal Naval Scientific Service requires SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS for Establishments in London area, Baldock, Portsmouth, Portland, Poole and Rosyth. Main requirements are for PHYSICISTS, MECHANICAL ENGINEERS, ELECTRONIC ENGINEERS and MATHEMATICIANS in areas specified. The following particular vacancies also exist: Mathematician: for applied research of basic nature on stability of underwater vehicles; knowledge of theoretical hydrodynamics and theory of control systems an advantage; London area. Mechanical Engineer: with sound knowledge of basic principles of thermo and fluid dynamics, to carry out research programme in a particular field of applied hydrodynamics. Experience in modern methods of design and research on axial flow compressors, turbines or pumps an advantage; London area. Mechanical Engineers: for design and development of underwater devices; Portland area. Physical Chemist: with specialised knowledge of rubber technology; Poole area. Chemists: Physical and Inorganic; Poole, Baldock and London areas. Candidates must normally be natural born British subjects of natural born British parents, with First or Second Class Honours Degrees. S.S.O.'s must have had three years' post-graduate experience and be not less than 26 years of age.

Salaries (men): S.S.O., £1233–£1460; S.O., £655–£1150 (London)—somewhat lower in provinces. Appointments are unestablished (with F.S.S.U. benefits), but opportunities may occur for those between ages of 21 and 32 to compete for established posts.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1 (quote A.500/8A). E5161

PUBLIC APPOINTMENTS

GOVERNMENT OF SINGAPORE

DEPARTMENT OF TELECOMMUNICATIONS

ASSISTANT CONTROLLER OF TELECOMMUNICATIONS

To manage staff and be responsible for maintenance, installation and operation of telecommunications equipment, including multi-channel carrier equipment, teleprinters and V.F. telegraph apparatus, overhead and underground plant, railway signalling equipment, multi-channel V.H.F. radar and microwave equipment and major receiving and transmitting radio stations.

Contract appointment for three years. Salary in the range £1290–£2338, according to experience. Temporary variable allowance £210–£560 per annum. Gratuity payable on satisfactory completion of contract. Free passages. Quarters, if available, at low rent. Generous home leave. Candidates, not over 45 years of age, must be Corporate or Graduate Members of the Institution of Electrical Engineers, or possess a University Degree or Diploma giving exemption from the Institution's examination and have at least two years' practical experience in Telecommunications.

Write, Director of Recruitment, Colonial Office, London, S.W.1, giving age, qualifications and experience, quoting BCD 133/25/03 (B). E5472

THURROCK URBAN DISTRICT COUNCIL

ENGINEER AND SURVEYOR'S DEPARTMENT

ENGINEERING ASSISTANT

Thurrock Urban District Council (Engineer and Surveyor's Department) require ENGINEERING ASSISTANT. Salary within A.P.T. I/II, i.e., £575–£845 p.a. Candidates should have completed their Training in a Municipal or Civil Engineer's Office and have had some subsequent experience. Appointment pensionable. Applications, stating age, qualifications and experience, and quoting three referees, to Clerk of the Council, Council Offices, Grays, by 28th April, 1959. Canvassing disqualifies. Relationship with Members or Senior Officers of the Council must be disclosed. E5496

EAST WORCESTERSHIRE WATERWORKS COMPANY

ENGINEER-MANAGER

Applications are invited for the appointment of ENGINEER-MANAGER. Candidates must be fully and suitably qualified and with the necessary experience of waterworks practice and administration, between the ages of about 45–50 years.

The salary will be £2500 per annum, rising to £3000 per annum.

The successful candidate will be required to pass a medical examination and to join the Company's superannuation scheme under the Worcestershire County Council.

Applications, giving the names of three persons to whom reference may be made, should be addressed to A. M. Hardy, F.C.I.S., Secretary, 2, Stourbridge Road, Bromsgrove, Worcestershire, to be received by 20th April, 1959, and endorsed "Engineer-Manager." E5469

COUNTY BOROUGH OF NEWPORT

APPOINTMENT OF SENIOR ASSISTANT ENGINEER

Applications are invited for the above appointment on the permanent establishment of the Borough Engineer's Department. The salary will be in accordance with A.P.T. IV—£1025–£1175 commencing within the Grade according to qualifications and experience.

Housing accommodation will be provided if necessary.

Applicants must be Chartered Civil or Municipal Engineers, and applications with copies of three recent testimonials should reach me by the 5th May, 1959.

E. A. MIDDLE,
Borough Engineer and Surveyor.
Civic Centre,
Newport, Mon. E5497

PUBLIC APPOINTMENTS

NEWCASTLE REGIONAL HOSPITAL BOARD

APPOINTMENTS

Applications are invited for the following posts on the staff of the Regional Engineer:

ASSISTANT ENGINEER—HEATING AND VENTILATING

Salary scale: £730 by £25 (2) by £30 (2) by £35 (5) by £40 (1) to £1055 per annum.

Applicants should have passed the appropriate sections of the Associate Membership Examination of the Institution of Mechanical Engineers or should be Associate Members of the Institution of Heating and Ventilating Engineers.

ENGINEERING ASSISTANTS—HEATING AND VENTILATING

Salary scale: Grade I, £680 by £25 (3) by £30 (1) by £35 (4) by £40 (2) to £1005 per annum; or Grade II, £545 by £20 (3) by £25 (4) by £30 (2) to £765 per annum.

The point of entry being in accordance with age, experience and technical qualifications. Applicants should have served a recognised engineering apprenticeship, having obtained a Higher National Certificate in Mechanical Engineering for Grade I post or an Ordinary National Certificate in Mechanical Engineering for Grade II post, or have otherwise passed an examination approved by the Ministry of Health.

The work is varied and interesting. It includes all types of central heating, hot water supply air conditioning plant, fully automatic sterilising equipment for Operating Theatres and more general sterilising equipment for Wards, Treatment Rooms and Clinics.

Candidates should be expert draughtsmen with experience in design work, preparation of working drawings and specifications, including details of equipment. The candidate would be expected to prepare the whole of the engineering services for large building projects.

Applications, stating age, qualifications, experience and present and previous appointments, together with the names and addresses of three referees (two technical), should be forwarded to the Secretary to the Board, Benfield Road, Newcastle upon Tyne, 6, within 14 days. E5507

PORT OF BRISTOL AUTHORITY

ENGINEERING ASSISTANT

Applications invited for above post. Candidates should be capable of preparing schemes with minimum of supervision from initial survey through calculations and preparation of drawings to final contract documents. Experience in dock engineering useful but not essential.

Salary: £1025 by £50 per annum to £1175. Commencing salary within this range will depend upon age, qualifications and experience. Medical examination and six months' probationary period. Post pensionable (Local Government Superannuation Act, 1953).

Applicants must disclose whether they are related to a member or senior officer of Bristol Corporation. Canvassing disqualifies.

Applications, stating age, qualifications, experience, &c., and enclosing, if possible, copies of recent testimonials, in envelopes endorsed "Engineering Assistant," to Engineer-in-Chief, Avonmouth Docks, Bristol, by 1st May. E5466

PRISON COMMISSION

(LONDON)

ENGINEER

ENGINEER, Mechanical and Electrical, for Prison Commission (London). Should be 25 or over and Corporate Member I.Mech.E. or I.E.E. (candidates with Higher National Diploma in Mechanical or Electrical Engineering considered, provided Corporate Membership gained within two years). Experience of installation and maintenance of Heating, Ventilation, Steam Hot Water and Electrical Services of large buildings, including design of layouts necessary. Knowledge of estimating, specifications and contract procedure essential.

Salary: £805–£1260, depending on age, experience, &c. Five-day week; some travelling; possibility of pensionable post; promotion prospects.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting C.244/9A. E5443

PUBLIC APPOINTMENTS

GREENWICH AND DEPTFORD HOSPITAL MANAGEMENT COMMITTEE

SENIOR ENGINEER

SENIOR ENGINEER, to be responsible, under the Superintendent Engineer, for the engineering services, mechanical and electrical, at St. Alfege's Hospital, Greenwich, S.E.10. Good practical engineering training, sound knowledge of steam boiler plant operation and supervisory experience in hospitals essential. Unless eligible for promotion through Health Service experience, applicants should have passed an examination in engineering technology and hold M.T.C.A. 1st Class Certificate of Competency in Marine Engineering or M.T.C.A. Certificate of Service as 1st Class Engineer, or City and Guilds Full Technological Certificate in Plant Engineering (1st Class).

Salary scale : £760–£910 per annum, including London Weighting. Whitley Council conditions of service. Superannuation scheme.

Applications, stating age, qualifications and experience and naming three referees, to Group Secretary, G. and D. H.M.C. at Hospital by 21st April. E5387

GOVERNMENT OF UGANDA

FACTORIES INSPECTOR (ENGINEERING)

FACTORIES INSPECTOR (ENGINEERING), preferably under 45, required to advise Chief Factories Inspector on implementation of requirements of Factories Ordinance relating to pressure vessels and lifting equipment and their testing and examination ; and to undertake an appreciable amount of such testing and examination. Candidates must possess A.M.I.Mech.E., M.I.Mar.E., or Degree in Mechanical Engineering, together with considerable experience as engineer surveyor with Insurance Company or industrial undertaking. Experience of pressure vessels and competency in seeing that safety regulations are met for superintending installation of boiler machinery also essential. Post permanent and pensionable or on contract/resettlement terms. Salary scale, £939 to £1863 inclusive. Where available, quarters provided at low rental. Free passages and medical attention. Outfit allowance. Tour of service 30–36 months. Generous home leave. Low income tax.

Further particulars and application form from the Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.132/9/02. Closing date for receipt of initial enquiries 15th May, 1959. E5448

BRITISH SHIPBUILDING RESEARCH ASSOCIATION

ATOMIC ENERGY SECTION

APPOINTMENTS

The British Shipbuilding Research Association has vacancies in its Atomic Energy Section for men aged about 25 with a good University Degree in Marine or Mechanical Engineering and with practical training and experience. Research experience an advantage. The persons appointed will be required in the first instance to work in the Association's team at the Atomic Energy Research Establishment, Harwell, studying the possible application of nuclear power to merchant ship propulsion. Experience of nuclear energy is not an essential qualification as training in this will be given. The commencing salaries will depend upon age and qualifications and the appointments are subject to the Federated Superannuation System for Universities.

Applications, with full particulars, should be addressed to : B.S.R.A., 5, Chesterfield Gardens, Curzon Street, London, W.1. E5453

ST. WOOLOS HOSPITAL, NEWPORT

ASSISTANT ENGINEER

ASSISTANT ENGINEER required. Salary : £545 by £20 (1) by £25 (3) by £30 (1) to £670 per annum. Candidates should possess, or be studying for, the Ordinary National Certificate. Excellent experience. Superannuation scheme.

Write, stating age and two referees, to T. A. Jones, Group Secretary, 64, Cardiff Road, Newport. E5509

PUBLIC APPOINTMENTS

SANDHILL PARK GROUP HOSPITAL MANAGEMENT COMMITTEE

SENIOR ENGINEER

SENIOR ENGINEER required as deputy to the Superintendent Engineer ; to be based at Sandhill Park Hospital. Salary scale (20½–30 points) £730 to £870 per annum.

Applicants must have passed an examination in Engineering Technology and hold one of the following qualifications or an equivalent qualification approved by the Minister of Health or Secretary of State for Scotland :

1. Ministry of Transport and Civil Aviation (Ex Board of Trade) First Class Certificate of Competency in Marine Engineering.
2. Ministry of Transport and Civil Aviation Certificate of Service as First Class Engineer.
3. City and Guilds Full Technological Certificate in Plant engineering (First Class).

Applicants must also have completed an apprenticeship in mechanical engineering or otherwise acquired a thorough practical mechanical engineering training and have a sound knowledge of the principles and practice of the efficient operation of steam boiler plants and have a wide experience in a supervisory position of such types of mechanical and electrical engineering services as are found in hospitals and appropriate to the responsibility of the post.

Some knowledge of building maintenance work would be advantageous.

Applications stating age, details of experience and qualifications and names and addresses of two referees, not later than 30th April, 1959, to the Group Secretary, Sandhill Park Hospital, Bishop's Lydeard, near Taunton. E5519

BRITISH TRANSPORT DOCKS

SOUTH WALES DOCKS

TWO POSITIONS OF ENGINEERING ASSISTANT

British Transport Docks invite applications for two positions of ENGINEERING ASSISTANT, South Wales Docks. Candidates should have had experience in the preparation of schemes and estimates for general civil engineering construction with some experience on works.

The starting salary for one of the posts will be £833 p.a. and preference will be given to candidates who hold an Engineering Degree and/or are Graduates of the Institution of Civil Engineers.

The commencing salary for the other post will be £943 p.a. and applicants should also have had experience in the construction and maintenance of civil engineering works preferably with some knowledge of maritime structures ; a knowledge of building construction will be an advantage. Corporate Membership of the Institution of Civil Engineers desirable and would attract, subject to experience, a higher salary range.

Travel facilities, superannuation scheme, &c.

Applications giving age, experience and qualifications to the Chief Docks Manager, British Transport Docks, Pierhead Buildings, Cardiff, to arrive not later than 24th April, 1959. E5500

LIVERPOOL REGIONAL HOSPITAL BOARD

ASSISTANT ENGINEER

ASSISTANT ENGINEER (Electrical) required on the staff of the Regional Engineer.

Applicants should have passed the Institution Examination and be Graduate Members of the Institution of Electrical Engineers ; have experience in the preparation of specifications, drawings and estimates for distribution schemes, electrical installations in hospitals and buildings and be able to take details of existing installations and have a good knowledge of modern installation practices.

Salary scale : £730–£1055 per annum. Starting salary depending on age and previous relative practical experience.

Applications, stating age, qualifications, experience, present and previous appointments, with names and addresses of three referees (two technical), to reach me at 55, Castle Street, Liverpool, 2, by 24th April, 1959.

VINCENT COLLINGE,
E5391 Secretary to the Board.

CENTRAL ELECTRICITY GENERATING BOARD

ASSISTANT ENGINEERS and PHYSICISTS required at the RESEARCH LABORATORIES, LEATHERHEAD, SURREY, to work on problems associated with ELECTROSTATIC PRECIPITATORS and with HEAT EXCHANGERS for nuclear power stations. In both cases much of the work will be of a fundamental nature, carried out on pilot-scale plant, and importance will be attached to a sound basic knowledge.

Salaries will be on scales within the ranges £1195–£1775 p.a., or £570–£1300 p.a., according to duties and responsibilities.

Candidates for the higher grade vacancies should have an Honours Degree with previous research experience ; for the other vacancies a pass Degree or H.N.C. would be acceptable.

Application forms obtainable from Personnel Officer, 24–30, Holborn, London, E.C.1, should be completed and returned by 4th May. Please mark envelopes " Confidential Ref. ENR/46A."

E5484

TENDERS

MINISTRY OF TRANSPORT AND CIVIL AVIATION

DARTFORD TUNNEL

ESSEX APPROACH ROAD

TENDERS are invited for the CONSTRUCTION of PART of the APPROACH ROAD to the tunnel. This involves : (1) the construction of approximately 1000 feet of reinforced concrete viaduct ; (2) piled foundations for the same by a nominated subcontractor ; (3) precast prestressed deck to the crossing over the railway ; (4) excavation and filling to formation level of new road ; (5) road foundation and surfacing ; (6) various ancillary works.

Tenderers may be asked to furnish details of comparable works they have carried out.

Copies of the contract documents may be obtained from the Consulting Engineers, Messrs. MOTT, HAY & ANDERSON, 9, Iddesleigh House, Caxton Street, Westminster, London, S.W.1, on payment of a deposit of £50 by cheque made payable to the Minister of Transport and Civil Aviation. The deposit will be returned if a bona fide Tender is submitted and not subsequently withdrawn.

Tenders should be sent by registered post, in envelopes clearly endorsed " Tender for Essex Approach Road," but not bearing any name or mark indicating the sender, addressed to the Assistant Secretary, Highways Management and Services Division, Ministry of Transport and Civil Aviation, 21/37, Hereford Road, London, W.2, to arrive not later than 4 p.m. on Tuesday, the 16th June, 1959.

The Minister does not bind himself to accept the lowest or any Tender.

H. GILLENDER,
E5457 An Assistant Secretary.

BOROUGH OF FALMOUTH

WATERWORKS CONTRACT NO. 14

BOOSTER PUMPS—COLLEGE WORKS

The Corporation invites TENDERS from Manufacturers having experience in similar work for the MANUFACTURE, SUPPLY and ERECTION of 3 (No.) ELECTRICALLY-DRIVEN LOW-LIFT CENTRIFUGAL PUMPS (30,000 g.p.h.) at the College Works, Penryn, together with Switchgear, Pipework, Automatic Control Equipment and Ancillary items.

Copies of the general conditions of contract, specification and form of Tender may be obtained from the Engineers, Messrs. Rofe and Raffety, 9, Brewer's Green, Buckingham Gate, London, S.W.1 on payment of a deposit of Two Guineas (cheque only), which will be returned on receipt of a bona fide Tender and the return of all documents supplied.

Tenders on the form supplied, together with description of the plant offered, must be delivered to the undersigned not later than 12 noon on Wednesday, 13th May, 1959, endorsed " Tender for Booster Pumps—Contract No. 14."

The Corporation does not bind itself to accept the lowest or any Tender.

E. J. K. GIBBONS,
Town Clerk.

Municipal Offices,
Falmouth.
17th April, 1959. E5516

INDIA SUPPLY MISSION

The office of the India Supply Mission, 2536, Massachusetts Avenue, N.W., Washington, D.C., United States of America, invites TENDERS for the following :—

(a) TENDER ENQUIRY No. SE.47.
For the SUPPLY of 5 TONS MOBILE CRANES, mounted on pneumatic-tyred wheels, diesel engine driven, complete with hydraulic Controlled Steering.

(b) TENDER ENQUIRY No. SE.34.
ONE (number) each of 100 TON and 65 TON INDOOR ELECTRIC OVERHEAD TRAVELLING CRANE required for the Bhadra River Power Station in India.

Specifications, &c., regarding the above enquiry can be obtained direct from the Co-ordination Branch, India Store Department, Government Building, Bromyard Avenue, Acton, W.3, at 14s. 3d. per set for (a) and £1 15s. 9d. per set for (b). Tenders are to be returned direct to India Supply Mission, 2536, Massachusetts Avenue, N.W. Washington, D.C., United States of America, so as to reach them by 4th June, 1959, for (a) and 1st May, 1959, for (b).

Specimen copy of the above specification can be seen at India Store Department, Government Buildings, Bromyard Avenue, Acton, W.3, under reference S.4436/58/NSC/ENG.2. for (a) and S.4317/58/NSC/ENG.2. for (b). E5459

ROYAL BURGH OF INVERNESS

NEW BRIDGE TO REPLACE SUSPENSION BRIDGE

The Council of the Royal Burgh of Inverness invite TENDERS for the DEMOLITION OF A SUSPENSION BRIDGE over the River Ness and the CONSTRUCTION OF A THREE-SPAN PRESTRESSED CONCRETE ROAD BRIDGE on the same site, together with certain road works, riverside wall remodelling and the removal of a temporary timber bridge.

A set of the Contract Drawings and Documents may be obtained from the Consulting Engineers, Sir M. MacDonald and Partners, 72, Victoria Street, London, S.W.1. Applications must be in writing and must be accompanied by a cheque for £15, payable to the order of the Council of the Royal Burgh of Inverness, which is returnable to bona-fide tenderers.

The Council do not bind themselves to accept the lowest or any Tender.

Tenders must be received by the undersigned not later than noon on Tuesday, 9th June, 1959.

JAMES CAMERON,
Town Clerk.

Town House,
Inverness. E5487

TENDERS

MERE AND TISBURY RURAL DISTRICT COUNCIL

COMPREHENSIVE SCHEME OF WATER SUPPLY—PART V : WITHIN TWENTY-ONE PARISHES OF THE DISTRICT

The Council invite TENDERS from experienced Civil Engineering Contractors for the CONSTRUCTION of TWO SMALL RESERVOIRS and the PROVISION and LAYING of approximately 36 MILES OF WATER MAINS and BRANCHES as under :

(1) 1000 yds. 6in. spun iron pipe.
(2) 13,300 yds. 4in. spun iron pipe.
(3) 31,100 yds. 3in. spun iron pipe.
(4) 4900 yds. 6in. asbestos cement pressure pipe.
(5) 2200 yds. 4in. asbestos cement pressure pipe.
(6) 11,000 yds. 3in. asbestos cement pressure pipe.
(7) Teffont reservoir of 65,000 gallon capacity.
(8) Sutton Mandeville reservoir of 20,000 gallon capacity.
(9) Valves, fittings and appurtenant works.

Contractors desirous of Tendering are requested to advise the Council's Consulting Engineers, Messrs. T. WARD WHITFIELD & SON, 54, Stallard Street, Trowbridge, Wilts., not later than 30th April, 1959, after which they will receive full particulars. The applications must be accompanied by a deposit of five guineas, which will be returned after receipt of a bona fide Tender.

Tenders in plain, sealed envelopes endorsed " Tender for Waterworks," must reach the undersigned by a date to be given by the Engineers.

The Council do not bind themselves to accept the lowest or any Tender.

M. E. BARRETT,
Clerk of the Council.

Council Offices,
Mere,
Wilts. E5454

MADRAS PORT TRUST

The Chief Engineer, Madras Port Trust, Madras, India, invites TENDERS for the following :—

(a) TENDER ENQUIRY No. 16/E.P.3/25483/59.
For the SUPPLY of ONE MOTOR-DRIVEN CONNECTING ROD FINE BORING MACHINE.

(b) TENDER ENQUIRY No. 16/E.P.3/24643/59.
For the SUPPLY of CRANKSHAFT GRINDING MACHINE.

(c) TENDER ENQUIRY No. 16/E.P.3/25484/59.
For the SUPPLY of a CYLINDER REBORING MACHINE.

(d) TENDER ENQUIRY No. 16/E.P.3/25482/59.
For the SUPPLY of ONE MOTOR-DRIVEN TURRET LATHE

(e) TENDER ENQUIRY No. 16/E.P.3/24635/59.
For the SUPPLY of a PLATE BENDING MACHINE

Specifications, drawings, &c., relative to the above Tender enquiries can be obtained direct from the Deputy Chief Accounts Officer (Engineering), Chief Engineer's Office, Madras Port Trust, Madras—1, India, on payment of : (a) 4s. 6d. per Tender set ; (b) 3s. per Tender set ; (c) 4s. 6d. per Tender set ; (d) 7s. 6d. per Tender set ; (e) 15s. per Tender set.

Tenders are to be returned to the Chief Engineer (" C " Warehouse), Madras Port Trust, Madras, India, so as to reach him by : (a) 8th June, 1959 ; (b) 19th May, 1959 ; (c) 25th May, 1959 ; (d) 3rd June, 1959 ; (e) 15th May, 1959.

Specimen copy of the above enquiries can be seen at India Store Department, Government Buildings, Bromyard Avenue, Acton, W.3, under the following references.

(a) S.4440/58/NSC/ENG.2.
(b) S.4439/58/NSC/ENG.2.
(c) S.4442/58/NSC/ENG.2.
(d) S.4441/58/NSC/ENG.2.
(e) S.4438/58/NSC/ENG.2. E5459

EDUCATIONAL

CHELSEA COLLEGE OF SCIENCE AND TECHNOLOGY
MANRESA ROAD, LONDON, S.W.3

DEPARTMENT OF MATHEMATICS

The next SANDWICH COURSE in Applicable Mathematics (of four years' duration) will begin in September, 1959. The course is recognised for the award of the Diploma in Technology. State Scholarships. Technical State Scholarships, and Local Education Authority awards may be held by students attending this course.

Enquiries are invited from students and also from industrial organisations, schools and further education establishments which may wish to recommend students for the course.

N. M. H. LIGHTFOOT, M.A., F.R.S.E.,
Principal.
E9915 z

TECHNICAL HOME STUDY COURSES

For A.M.I.Mech.E., A.M.I.Chem.E., A.M.I.M.I., A.F.R.Ae.S., C. & G., &c.

OVER 50 FIRST PLACES and more than 2000 Passes have been secured by T.I.G.B. Students at Professional Engineering Examinations. We have a wide range of exclusive Home Study Courses in all branches of Engineering—Mechanical, Electrical, Aeronautical, Automobile, Chemical, Gas, Radio, and Television, Draughtsmanship, &c. Textbooks, blueprints, &c., are provided and, if desired, fees may be paid by moderate instalments.—Write (stating subject of interest) for copy of 110-page Prospectus FREE and without obligation.

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29, WRIGHTS LANE, LONDON, W.8.
F102 z

Classified Advts. continued on page 136

EDUCATIONAL

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent. successes. 148-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 F

AUTOMATION.—AUTHORITATIVE COURSES are now available in Digital and Analogue Computer Technology, Applied Electronics, Data Processing and Instrumentation up to professional level by home study. Individual enrolment or industrial group scheme enrolments accepted. Syllabuses and prospectus sent on request.—Write (Dept. S.E.8), E.M.I. Institute School of Electronics, College House, Kensington, London, W.8. E145 F

ENGINEERS TRAIN FOR TECHNICAL TEACHING

Technical Teaching offers excellent prospects, good Salaries, and Security.

Applications are invited from ENGINEERS for TRAINING as FULL-TIME TEACHERS

The next course of Training will begin in September, 1959, and end in June, 1960.

Applicants should

(1) Be between about 25 and about 45 years of age ;

(2) Have Industrial Experience ;

(3) Possess one of the following :

Higher National Certificate

Full Technological Certificate of the City and Guilds of London Institute,

Professional Qualifications or Degree.

Substantial Grants available free of Income Tax and normally Free Tuition, Board and Lodging.

Write for details and an Application Form to one of these Colleges :

The Director (E/2/10), Bolton Training College, Manchester Road, Bolton.

The Principal (E/2/10), Garnett College, 83, New Kent Road, London, S.E.1.

The Director (E/2/10), Huddersfield Training College, Holly Bank Road, Lindley, Huddersfield. (767) E5478 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES, NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A CHIEF MECHANICAL ENGINEER is required by a leading and expanding Group in the North-East to take charge of the Engineering Division. Candidates should have experience in the maintenance and repair of building and civil engineering equipment, ready-mixed concrete and sand and gravel plants. Qualifications are desirable, but not essential. Prospects are excellent, a car is provided and a pension scheme is in operation.—Applications, which will be treated in the strictest confidence, should be addressed to the General Manager, BOX No. E5462, " The Engineer." A

A PLANT MANAGER required to take full charge of opening a new medium-size precision ball plant. Very attractive salary and bonus.—Application, which will be treated in the strictest confidence, with full details of experience and qualifications, to BOX No. E5321, " The Engineer." A

ASSISTANT TO SALES MANAGER

An opportunity in Sales arises for a young man approximately 35 years of age who has first class commercial experience in Engineering Machine Tools to generally assist the Divisional Sales Manager in the preparation of sales correspondence and quotations.

A sound background in gearing is essential and a knowledge of gear cutting machine tools would be an advantage.

The successful applicant must have a good personality, be capable of meeting customers at all levels and must be prepared to reside in the North West of England.

A good salary will be paid and an excellent superannuation scheme is in operation.

Details including age and experience.—BOX No. E5505, " The Engineer."

A

BIRLEC HEATING DIVISION SALES DEPARTMENT WANT FURNACE DESIGN ENGINEER. Duties include discussions with customer and liaison with Engineering Department Designers and Estimators, and preparation of Project and Tender Specifications. H.N.C. or Engineering Degree standard.—Apply to Personnel Manager (JMP), Birlec Ltd., Tyburn Road, Birmingham, 24. E5476 A

CADBURY BROTHERS LTD. have a vacancy for an ELECTRICAL ENGINEER to take charge of electrical maintennnce at their factory at Moreton, Wirral, Cheshire. Experience in High Tension Switchgear and Power Distribution is necessary and a knowledge of Electronic Principles would be an advantage.—Applications, giving full details of age, training, technical qualifications, experience and present salary should be sent to MOD/E5, Cadbury Bros., Ltd., Pasture Road, Moreton, Wirral. E5450 A

CONSULTING ENGINEERS engaged on varied r.c. and steel structural works, general civil engineering work and foundation problems, require capable assistants for design and detailing. Five-day week and luncheon vouchers.—Apply : MAURICE NACHSHEN AND PARTNERS, 58, Victoria Street, London, S.W.1. E5501 A

DESIGN ENGINEERS AND SENIOR DRAUGHTSMEN required for North London firm of mechanical engineers. Experience in mechanical handling and/or bottling plant an advantage. Initial salary not less than £1000 p.a. for first-class men of initiative and responsibility. Canteen facilities. Pension scheme. Apply with full particulars.—BOX No. E5468, " The Engineer." A

CHIEF DRAUGHTSMAN WANTED for Crane Works manufacturing wide range of heavy Steelworks and Dockside Cranes ; good salary ; pension scheme. State age, experience and salary expected.—BOX No. E5451, " The Engineer." A

DESIGN DRAUGHTSMAN required for mechanical design of nucleonic instruments. Pleasant working conditions. Excellent rates of pay.—Apply Chief Draughtsman, ISOTOPE DEVELOPMENTS, LTD., Beenham Grange, Aldermaston, Berks. Tel.: Woolhampton 451. E152 A

DESIGN ENGINEERS with up to 9 years' experience wanted by Consulting Engineers for Heavy Reinforced Concrete work for Power Stations. Salaries in accordance with experience. Pension Scheme. Five-day week.—Apply SIR WILLAM HALCROW AND PARTNERS, Alliance House, Caxton Street, London, S.W.1. Tel.: Abbey 4061. E5455 A

DESIGNER-DRAUGHTSMAN, experienced in Heavy Oil Engines, Marine experience an advantage. Qualifications ; H.N.C. and practical background. Age group 25–30 years, required by small firm building Marine Oil Engines, in powers up to 1600 H.P. Salary £800 to £950, according to qualifications. Non-contributory pension scheme, house available for married man.—Apply, with full particulars, to THE NEWBURY DIESEL CO., LIMITED, NEWBURY, Berks. E5402 A

DESIGNER DRAUGHTSMAN (MECHANICAL) required for Research and Development Team engaged on interesting development work in connection with special structures and diesel and steam operated plant. Minimum qualifications H.N.C. Age group 24–30 years. The appointment is permanent and progressive in an expanding organisation. Contributory Pension Scheme and good canteen facilities. Holiday arrangements respected. Salary in accordance with age, qualifications and experience. The works are situated 15 (fifteen) minutes 'bus journey from the centre of Ipswich.—Applications to the Personnel Officer, THE BRITISH STEEL PILING COMPANY, LTD., Claydon, Suffolk. E5477 A

DESIGNERS/DRAUGHTSMEN.—Consulting engineers handling a wide variety of design projects have vacancies for all grades up to Degree standard, in the following fields :—

Mechanical Engineering
Nuclear Engineering
Electrical Engineering
Chemical and Plant

Pension scheme and three weeks' annual holiday after qualifying periods.—NORRIS BROTHERS, LIMITED, 62, Church Road, Burgess Hill, Sussex.

E5377 A

DESIGN ENGINEER

required for the investigation, carrying-out of preliminary trials, and the setting-up of production of Mineral Insulated Cables.

Applicant should have both theoretical and practical experience ; age 28 to 40 years old.

Apply :
The Manager,
GLYNWED PLANT, LTD.,
Bilston, Staffs.

E5474 A

DEVELOPMENT DIVISION is expanding its department handling all types of tyres. Keen men with engineering or technical training or experience are required. Tyre experience is not necessary, since the work covers tyre materials, design, manufacture, costing, production, and use, and offers the opportunity quickly to obtain a broad technical experience, with prospects of promotion.—Please write, giving brief details and commencing salary expected, to Personnel Manager (quoting reference J.M.169), DUNLOP RESEARCH CENTRE, Erdington, Birmingham, 24. E5438 A

SENIOR DRAUGHTSMEN

and

ELECTRICAL ENGINEERS

are required by

THE BELMOS COMPANY, LTD.

at their Bellshill, Blantyre and Bothwell factories, with the minimum qualification of H.N.C. or equal, and age over 25 years, for work on motor control gear and small mechanisms. Applicants should have experience in one of the following fields :—

Sheet metal work.
General mechanical design.
Electrical layout.
Development design.
Jig and Tool design.
Circuit design.

Salary in accordance with experience ; five-day week.—Applications to The Belmos Company, Ltd., Bellshill, quoting ref. JM/78.

E5417 A

ENGINEER REQUIRED by the Atomic Weapons Research Establishment, Aldermaston, Berks, to be responsible to a Senior Engineer for the engineering designs of a wide variety of mechanical, chemical and air-conditioning plant for conventional, radioactive and toxic buildings.

A recognised engineering apprenticeship and Corporate Membership of a Senior Engineering Institution or equivalent qualifications required.

Experience in some of the following would be an advantage :—Mechanical services ; air conditioning and ventilation ; chemical plant design from flow sheet stage ; pressure vessels ; estimating and the preparation of schemes and design studies.

Salary : £845 (at age 25) to £1150 (at age 34 or over) to £1315.

Contributory superannuation scheme. A house or, alternatively, substantial assistance with house purchase, will become available for married officers living beyond daily travelling distance.

Postcards for application forms to the Senior Recruitment Officer at above address. Please quote ref. 2221/25. E5442 A

ENGINEERING SUPERVISOR required by fine chemical manufacturers in south Birmingham, to take charge of a general fitting shop of 35–40 men engaged on a wide variety of repair, maintenance and plant installation work. This is a senior staff appointment and applicants should be aged between 35 and 45 years, with wide practical experience and accustomed to handling men. The appointment is permanent and offers excellent working conditions in pleasant surroundings, superannuation scheme, canteen facilities, &c., and assistance with housing. Salary will be in accordance with qualifications and experience.—Apply in writing, giving details of experience, &c., to Chief Engineer, JOHN AND E. STURGE, LTD., Lifford Chemical Works, Birmingham, 30. E5458 A

ENGINEERING STAFF

required by the United Kingdom Atomic Energy Authority in the Research and Development Laboratories, at Capenhurst, Chester, to fill the following posts :—

(a) SENIOR DESIGN ENGINEER (ref. 3004/J1)—to take charge of an office responsible for design of experimental chemical engineering plant and equipment ; mechanical pumps and other components ; compressors and heat exchangers ; and of large-scale rigs for test purposes which are frequently operated under unusual conditions.

A sound theoretical background and experience in the control of a design team on experimental work is required, together with some knowledge of liquid metal technology, chemical engineering, and high vacuum work. Salary between £1855 and £2155, according to qualifications and experience.

(b) CONSTRUCTION ENGINEER (ref. 3005/J1)—to be responsible for a team constructing test rigs and pilot scale plant from specifications and flow sheets, to meet fixed programme completion dates. The work covers an unusually wide range of chemical, mechanical, high-pressure and vacuum plant.

Experience in the control of labour is essential, whilst some knowledge of estimation and job costing would be an advantage.

(c) OPERATING ENGINEER (ref. 3006/J1)—to lead a team of professional and supporting staff operating a wide range of experimental rigs on problems associated with gaseous diffusion plant and various reactor projects.

Experience in the control of experimental plant and labour is essential.

Salary between £1345 and £1800 according to qualifications and experience.

(d) ASSISTANT ENGINEER (ref. 3007/J1)—to be engaged on work associated with the construction and operation of test rigs and prototype plant connected with various Authority reactor and process plant projects, and on the development of components and engineering techniques in the fields of bearings, seals and compressors.

Some experience in the fields mentioned is desirable.

(e) ASSISTANT INSTRUMENTS ENGINEER/PHYSICIST (ref. 3008/J1)—to join a section concerned with instrumentation studies in connection with nuclear reactors and associated large-scale chemical processes ; studying new processes ; and recommending instrumentation and data handling systems.

Some experience in process instrumentation or instrument development is essential, and a knowledge of electronic practice, commercially available instruments, and data handling systems would be an advantage.

Salary between £845 (at age 25) and £1315.

A recognised engineering apprenticeship and Corporate Membership of a Senior Engineering Institution, or equivalent, are essential for posts (a) to (d), whilst for post (e) applicants must have similar qualifications or possess an Honours Degree, or equivalent, in Physics.

Contributory superannuation. Staff housing scheme.

Send postcard for application form, quoting appropriate reference, to Recruitment Officer, U.K.A.E.A., I.G.H.Q., Risley, Warrington, Lancashire.

Closing date : 27th April, 1959.
31st March, 1959. E5439 A

ENGINEERS FOR MIDDLE EAST

(a) QUALIFIED ENGINEERS with 10 years' experience design and construction pipeline, pump stations and tank farms, for Middle East.

(b) QUALIFIED HYDRAULIC ENGINEERS with 5 years' experience design pipeline system, for Middle East.

(c) MECHANICAL ENGINEERS with extensive experience pipeline, pump stations and tank farms construction, for Middle East.

Submit curriculum vitae stating whether for (a), (b) or (c) to BOX No. 2473, c/o Charles Barker and Sons, Ltd., Gateway House, London, E.C.4.

E5498 A

EXCELLENT OPPORTUNITY EXISTS for WORKS TRAINED ENGINEER having sound technical qualifications. Age 28–35 years, of good appearance, pleasant personality. Duties initially selling machinery to Mining Companies, National Coal Board and Quarries. Remuneration salary or salary and commission, car provided, ultimate objective sales control and Board within ten years. Contributory Pension Scheme.—Write full particulars experience to Managing Director, PEGSON, LTD., Coalville, Leicestershire. E5452 A

JUNIOR SALES ENGINEER required by Yorkshire manufacturer of heavy industrial gears. Must be technically trained at least up to H.N.C. standard. Excellent opportunity for a man with drive, initiative and the right experience. Write, with full details of past career and required salary.—BOX No. E5427, " The Engineer." A

ESTIMATOR required for interesting work in connection with steel structures, hoisting machinery (steam, diesel and electric) and contractors' plant. Previous experience in estimating for general engineering essential. Preference given to applicant with some previous drawing-office and works training. Candidates should have O.N.C. qualification. Age 25–30. Contributory pension scheme, canteen facilities and convenient transport.—Apply in writing, giving full particulars of age, experience, qualification and salary required, to The Personnel Officer, THE BRITISH STEEL PILING CO., LTD., Claydon, Suffolk. E5334 A

FYLDE WATER BOARD

(a) ASSISTANT ENGINEER—Salary Scale A.P.T. IV (£1025–£1175).

Applicants must be Corporate Members of the Institution of Civil Engineers, and whilst waterworks experience is desirable it is not essential.

(b) ASSISTANT ENGINEER—Salary Scale A.P.T. IV (£1025–£1175).

Applicants must be Corporate Members of either the Institutions of Structural or Civil Engineers. A sound knowledge and experience of modern methods of design and construction of reinforced concrete or steel structures is essential.

(c) DRAUGHTSMAN—Salary scale A.P.T. I (£575–£725).

Applicants must be neat and expeditious draughtsmen with an aptitude for architectural or civil engineering work. Some experience of building construction and chain surveying and levelling will be an advantage.

(d) DRAUGHTSMAN/WOMAN—Salary scale Miscellaneous Div. IV (£565–£625).

Applicants must be neat and expeditious draughtsmen preferably experienced in the tracing of Ordnance Plans and General Civil Engineering drawings.

The Board has an extensive capital works programme in hand amounting to over £2,500,000 during the next five years. Successful applicants will, therefore, have ample opportunities for an interesting career. The Board at present supply an area of 210 square miles and a population of 290,000. In 1960 several adjoining water Authorities are to amalgamate with the Board, increasing the population to nearly 500,000.

In respect of appointments (a) and (b), application forms and further details of work in hand may be obtained from Frank Law, B.Sc.Tech., M.I.C.E., Engineer to the Board at the address below.

Applications for posts (c) and (d) should be by letter to the Engineer, and should be accompanied by small samples of the applicant's draughtsmanship, together with COPIES of two testimonials, and details of education, qualifications, experience and age.

Last date for applications—Monday, 11th May, 1959.

The appointments will be subject to the provisions of the Local Government Superannuation Acts, and Regulations thereunder, and successful applicants will be required to pass a medical examination.

Head Office,
Sefton Street,
Blackpool.
April, 1959. E5470 A

MECHANICAL AND ELECTRICAL ENGINEER required by London consultants. Work covers layout of wide variety of industrial plants and design process services and mechanical handling. General engineering experience particularly as to application of services to plant operation essential, but not specialisation such as workshop management and production. Post is as a Senior Engineer with good prospects, and salary will be assessed in relation to experience. Vacancy is not a temporary one and within a reasonable age carries staff pensions.—BOX No. E5461, " The Engineer." A

MECHANICAL ENGINEER

COURTAULDS, LIMITED, Chemicals Division, requires a Graduate (or qualified) MECHANICAL ENGINEER for its large chemical manufacturing plant near Manchester. In addition to the day to day manufacture of heavy chemicals (which offers a great variety of work) there is also scope for investigational and development work on the design of new plant and on the maintenance side of works engineering. In short, the work combines traditional workshop practice with an original approach to new problems and requires an absence of professional prejudice. It also provides opportunities for a man to follow his own work through to the final fruition of commissioning and operation. Previous industrial experience is desirable but a new graduate would be considered if he has had practical vacation experience. The post is pensionable and the occupant will be eligible for the Company's Co-partnership Scheme.

Candidates should write for a detailed form of application to the Director of Personnel, Courtaulds, Ltd., 16, St. Martin's-le-Grand, London, E.C.1, quoting reference number H.13.

E5480 A

REQUIRED BY A LARGE GROUP OF COMPANIES situated on the South Coast, DRAUGHTSMAN, experienced in general civil engineering and pipe work for fuel oil installations. Write, giving full details of age, experience, salary required, &c.—Contributory pension scheme in operation.—BOX No. E2358, " The Engineer." A

SALES ENGINEER, experienced in materials handling equipment, required by large progressive company in the Reading area, to expand the sales of automatic mechanical handling plant. All replies will be treated in the strictest confidence and applicants should give full details of sales and engineering experience, together with salary anticipated.—BOX No. E5465, " The Engineer." A

SENIOR DRAUGHTSMAN/DESIGNER required to assist in Ship Propulsion Design and Drawing-Office work, with a view to eventually taking charge of this function. Attractive salary. Pension scheme.—Apply in writing to the Managing Director, BRUNTONS (SUDBURY 1919) LIMITED, Sudbury, Suffolk. E5393 A

SITUATIONS VACANT

SALES ENGINEER. We seek a Technical Representative for N.E. Midlands, based Nottingham area, around 27–30, not necessarily with previous sales knowledge but possessing education, engineering experience, alertness, persistence, and integrity which will be well rewarded by good basic salary, commission, car, expenses, pension by progressive engineering company. Full career details, please, in confidence.—MARKLAND SCOWCROFT, LTD., Bromley Cross, Near Bolton. E2362 A

SALES ENGINEER
MANCHESTER AREA
DAVID BROWN INDUSTRIES, LIMITED
MACHINE TOOL AND TOOL DIVISIONS

A vacancy arises for a SALES ENGINEER to represent the Machine Tool and Tool Divisions in the Manchester Area.

Previous engineering sales and technical experience is essential, preferably on Gear Cutting and Gear Production Tools.

Good salary. Three weeks' Annual Holiday. Good Superannuation Scheme. Free Life Assurance. Company car provided.

Applications giving full details of education, experience and an indication of the salary expected should be addressed in confidence to :

The Chief Personnel Superintendent,
DAVID BROWN INDUSTRIES, LTD.,
Park Works,
Huddersfield.

E5504 A

SENIOR APPLICATIONS ENGINEER required by rapidly growing London Lubrication Equipment Company. Post involves laying out and advising engineering of centralised lubrication schemes and may lead to Executive position. Good engineering background, keenness and capacity for hard work essential. Knowledge of steel works, German and lubrication an advantage. Reply in confidence to Managing Director, stating experience, age and salary required.—BOX No. E5394, "The Engineer." A

SENIOR DESIGN DRAUGHTSMAN required for interesting work on mechanical engineering projects. Knowledge of hydraulics an advantage.—CHAMBERLAIN INDUSTRIES, LTD., Staffa Road, Leyton, E.10 (LEY 3678). E5499 A

SENIOR DESIGN ENGINEER required for development and production design of high-speed centrifugal equipment. Good Degree or equivalent qualification. Experience of high-speed machinery desirable. Age 28–36. A practical and enthusiastic attitude to commercial engineering essential.—Write, in confidence, giving full details, to The Managing Director, SHARPLES CENTRIFUGES, LIMITED, Tower Works, Doman Road, Camberley, Surrey. E5385 A

SENIOR DRAUGHTSMEN REQUIRED by a large engineering company in Central London, for work on chemical plant services. Applicants must have had several years' experience on instrumentation design, e.g. flow pressure and temperature controls of pneumatic and electrical operation and be able to work with the minimum of supervision. High commencing salaries and good working conditions, staff pension scheme in operation, holiday arrangements honoured. Please write, giving past experience and qualifications.—BOX No. E5506, "The Engineer." A

SENIOR STRUCTURAL STEELWORK DESIGNER/DRAUGHTSMAN (TWO), with several years' varied experience, age 30–40, one of above with Estimating Office experience.—Write to THE SECRETARY, Richards Structural Steel Company, Ltd., Phoenix Iron Works, Leicester. E2363 A

TECHNICAL AUTHOR

A vacancy exists in the Publicity Department for a qualified Electrical Engineer with the ability to write clear and concise descriptive sales literature.

Please write in the first instance, stating experience, to ref. JM/79.

THE BELMOS COMPANY, LIMITED,
BELLSHILL, LANARKSHIRE.

E5416 A

TECHNICAL EDITOR REQUIRED by rapidly expanding organisation in the East Midlands. This appointment carries an excellent starting salary and offers considerable scope for development to a man with ability, energy and a wide knowledge of production and mechanical engineering. Excellent superannuation scheme and pleasant surroundings. Send details of career and present salary.—BOX No. E5446, "The Engineer." A

TRANSLATORS REQUIRED for translation of technical periodicals, books, &c., from and into Russian. Sound knowledge of mechanical or production engineering essential. These are key positions in a rapidly expanding organisation in the East Midlands, with excellent prospects of advancement, working conditions and superannuation scheme.—Send full details to the Secretary, PRODUCTION ENGINEERING RESEARCH ASSOCIATION, Melton Mowbray, Leics. E5445 A

UNILEVER invite applications for the appointment of an ASSISTANT ENGINEER to the Mechanical Engineering Department of their London Office. Applicants should be qualified and have had substantial experience in steam generation and utilisation with a good knowledge of combustion and water treatment : further experience in heating and ventilation would be an advantage.—Written applications, with full particulars of qualifications, training and experience, to be addressed to : Personnel Division (GOS/408), Unilever, Limited, Unilever House, Blackfriars, London, E.C.4. E5510 A

WE WISH TO ENGAGE PETROLEUM ENGINEERS with good Refining experience and fully qualified in Process Design.—Please contact Personnel Manager, HEAD WRIGHTSON PROCESSES, LTD., 16-26, Baltic Street, London, E.C.1. (Phone : CLE 1299). E5479 A

UNILEVER, LIMITED, have a vacancy at a senior level for a REFRIGERATION ENGINEER at their London Office. Applications are invited from qualified Engineers who have experience with the planning, installation and maintenance of cold stores, refrigeration equipment and refrigerated transport. Additional experience in food processing equipment would be an advantage.—Full details of training, qualifications and experience should be addressed to : Personnel Division (GOS/407), Unilever, Limited, Unilever House, Blackfriars, London, E.C.4. E5511 A

WORKS MANAGER

Our production resources, mainly devoted to electrical machines and control gear, need co-ordinating to meet real challenge of an expanding programme. We're a progressive Northern company of medium size with an enthusiastic team of other executives.

Can you convince us, by your record of practical achievement to date, that productivity will eclipse problems under your leadership ? This job demands the vigorous approach of an "under 45" who can co-operate as ably as he controls.

Salary and benefits will reward success progressively. Qualified managers are invited to apply, indicating salary bracket, in knowledge that letters will enjoy extreme confidence.
BOX No. E5464, "The Engineer." A

PRESSED STEEL COMPANY LIMITED
Railway Carriage & Wagon Division
PAISLEY, SCOTLAND

have some additional appointments for

SENIOR DESIGN ENGINEERS

for work on

RAILWAY ROLLING STOCK, INCLUDING DIESEL AND ELECTRIC MULTIPLE UNITS

The work involved includes structural design, engine and equipment layout, interior trim and styling, and offers considerable scope for advancement. Salary according to age, experience and qualifications. First-class conditions of employment, including Contributory Pension Scheme, &c.—Applications to Personnel Manager.

E5374 A

SHELL

SHELL CHEMICAL COMPANY LIMITED
require a
SOLIDS HANDLING ENGINEER
for their
LONDON OFFICE

Candidates should be up to 40 years of age with a Degree in Mechanical Engineering and/or the equivalent professional qualification. At least 10 years' experience in the process industries and especially in solids handling is necessary, preferably including the handling of ore, powder and granules, with a knowledge of their transportation, storage, size reduction and blending, as well as drying, colouring and extrusion.
Salary according to qualifications and experience. Attractive pension scheme.
Applications with full details to :
Shell Chemical Company, Limited,
Staff Department/M4,
Clements House,
14/18, Gresham Street,
London, E.C.2. E5373 A

CJB

CONSTRUCTORS JOHN BROWN LIMITED

require immediately
for service in Middle East

PIPING DRAUGHTSMEN

Candidates are required to have a knowledge of plant lay-outs, piping designs, and arrangements, material take-offs, &c., for the oil and allied industries.

A minimum of 5 years' Drawing Office experience and a knowledge of A.P.I./A.S.M.E. codes is required. H.N.C. and some site experience are desirable but not essential.

Apply to :
The Personnel Manager,
CONSTRUCTORS JOHN BROWN, LTD.,
C.J.B. House, Eastbourne Terrace,
Paddington, London, W.2.
Please Quote Ref G. 6224.

E5471 A

TORSIONAL VIBRATION ENGINEER

A well-known firm of engineers in London, having an outstanding reputation in its field, requires the services of a specialist on torsional vibration. This appointment, which is pensionable, is one of responsibility calling for a man of proved ability and mature experience. Applications, which will be treated in the strictest confidence, are invited from men with a good degree or its equivalent and at least five years' specialised experience of torsional vibration work, preferably following a period of some practical engineering.—Applications should be addressed to BOX No. E5379, The Engineer."

A

WILKINSON SWORD

RESEARCH GROUP

Vacancies exist for Graduates in Chemistry, Physics, Metallurgy or Mechanical Engineering in an expanding Research Group. Wide interests include cutting edges, combustion problems and temperature sensing.

Outstanding opportunities for Graduates keen to undertake original work. Applications should contain detailed career summary, age, qualifications and salary required.

Research and Development Manager, WILKINSON SWORD LIMITED, Poyle Mill Works, Colnbrook, Bucks.

E5488 A

ENGLISH ELECTRIC

Whetstone, Near Leicester

wish to engage a

PROJECTS ENGINEER

for the Works Engineer's office. He will be responsible for factory and laboratory alterations and extensions in an establishment largely engaged on prototype manufacture and development in relation to Industrial Gas Turbines and Atomic Power Projects.

Applicants in the 30–40 age group, should be of at least H.N.C. level in Mechanical Engineering, have served a recognised apprenticeship, and have at least three years' experience on work of a similar nature to that described above.

Please write, giving details of qualifications and experience, to Dept. C.P.S., Marconi House, 336/7, Strand, London, W.C.2, quoting reference E 1917G.

E5495 A

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Telephone : CENtral 6565

Classified Advts. continued on page 138

SITUATIONS VACANT

TECHNICAL MANAGER

TECHNICAL MANAGER required for Division of a large Public Company, engaged in the light and medium heavy engineering industry, to be responsible for all Engineering, including Design and Development, and to represent the Division in the technical field.

Candidates should have considerable experience of design and manufacture in the Railway Rolling Stock Industry in a Senior Executive capacity, coupled with substantial engineering qualifications.

The appointment, which is a senior one, arises from continued expansion of the Company and offers considerable opportunities. Remuneration will be commensurate with the scope of the position, governed by experience and qualifications.

Applications, with full details of curriculum vitae and salaries earned will be studied at Board level and may be made in strict confidence to Box No. 2448, c/o Charles Barker and Sons, Ltd., Gateway House, London, E.C.4.

E5444 A

SITUATIONS VACANT

NORTH BRITISH RUBBER AND U.S. RUBBER OF AMERICA

continuing the expansion of their production facilities at Castle Mills, Edinburgh, require a qualified Engineer for the Industrial Engineering Division. Candidates, aged 27–40, should have good design experience, particularly with reference to jigs, tools and mechanisms, and must have the initiative and energy to follow through to a successful conclusion the transformation of basic ideas into improved production facilities. A flair for this kind of work is more important than technical qualifications but a Degree or Corporate Membership of an Engineering Institution would be an advantage. An attractive salary will be offered to the successful candidate, and Company benefit s include a contributory superannuation scheme and free Life Assurance. The Company are also prepared to assist with removal expenses. Applications, marked E, giving full details of qualifications, experience and age, should be addressed to Industrial Relations Division, The North British Rubber Co., Ltd., P.O. Box 47, Castle Mills, Edinburgh, 3. E5503 A

SITUATIONS VACANT

ENGLISH ELECTRIC RUGBY

STEAM TURBINE DIVISION

EXPERIENCED DESIGN DRAUGHTSMEN are required to fill the following vacancies :

(a) Design of large steam turbines for power generation. Age 30–40, with at least ten years' mechanical D.O. experience. Full apprenticeship and H.N.C.

(b) Power station layout draughtsmen. Must be experienced in piping runs, design of foundations and layout of generating plant.

(c) Condenser design draughtsmen with experience of condenser and feed heating design.

These are senior vacancies, offering good prospects of advancement to design departments, for men who are fully qualified and experienced. Please write, giving full details, to Dept. C.P.S., Marconi House, 336/7, Strand, London, W.C.2, quoting reference E 1199R.

E5494 A

SITUATIONS VACANT

SHELL

SHELL CHEMICAL COMPANY LIMITED

require a

SENIOR UTILITIES ENGINEER

for their

LONDON OFFICE

Candidates should be aged 35–45 years with A.M.I.Mech.E. or A.M.I.E.E. Experience in power house operation, water pumping scheme and general utilities is necessary. Experience in mechanical handling an advantage. Salary according to qualifications and experience. Attractive pension scheme.

Applications with full details to :
Shell Chemical Company, Limited,
Staff Department/M3,
Clements House,
14/18, Gresham Street,
London, E.C.2.

E5371 A

MECHANICAL ENGINEERS

Qualified Mechanical Engineers of around 30 years of age are required for vacancies in a Research and Development Unit near London Airport, concerned with small mechanisms and top quality domestic cutting implements. Applicants holding a Degree or H.N.C. or qualified Draughtsmen, should apply if they can justify a salary in excess of £1000 per annum and make important contributions to original design and development work.

—BOX No. E5489, " The Engineer."

A

BRITISH OXYGEN ENGINEERING LTD.

invite applications for

DEVELOPMENT ENGINEERS

to join a team engaged in development work on Plants operating at Low Temperature.

This new field of endeavour offers considerable scope to engineers with a good Degree or equivalent and who have experience in the design of various types of compressors, heat exchangers and pressure vessels.

The Company offers excellent conditions of service and pursues a progressive salary policy. Assistance with housing may also be given.

Applications in writing, giving age, qualifications, experience and present salary, should be addressed to :—

Employment Officer (E/G.4540),
British Oxygen Engineering, Ltd.,
Angel Road, Edmonton, N.18.

E5508 A

Hawker Siddeley **INDUSTRIAL DIVISION**

The General Engineering Division of Brush Electrical Engineering Company Limited, Loughborough, which is responsible for the design and layout of complete steam and diesel power stations, factory electrification projects and the application of electrical energy to industrial uses generally, wishes to recruit staff in accordance with details given below. The work is interesting and varied and offers unique opportunities for the exercise of initiative and engineering ability.

JUNIOR ENGINEERS (1 Electrical and 1 Mechanical)

Recognised Apprenticeship and Graduateship of the appropriate Institution. For the Electrical Post applicants should have had three years' general experience in electrical engineering and be able to prepare schematic diagrams, electrical layouts, cable schedules and lighting schemes from written specifications. For the Mechanical Post applicants should have had at least three years' experience in the design of steam power station equipment, including steam and cooling water piping systems. For both posts drawing office experience will be an advantage.

DRAUGHTSMEN (1 Mechanical and 1 Electrical)

Recognised Apprenticeship and possession of an appropriate Ordinary or Higher National Certificate. For Electrical Posts, applicants should have had three years' experience in the preparation of schematic diagrams, layouts of electrical equipment and detailing cable schedules. For Mechanical Posts applicants should have had three years' experience in the layout of steam turbine and boiler plant, including associated pipework. Good salaries will be offered and there is an attractive pension scheme.

Applications, which will be treated in the strictest confidence, should give brief personal details, particulars of training and previous experience, and be addressed to the
Chief Personnel Officer,
Brush Electrical Engineering Company Limited,
Loughborough, Leics., quoting reference R5066.

E5467 A

SPERRY **INDUSTRIAL DIVISION**

Due to continuing expansion at Brentford, the Sperry Gyroscope Company has created a separate Industrial Division in which vacancies are occurring at all levels.

DESIGN ENGINEERS

with experience in the following fields, are particularly required :

1. Transistorised circuitry for analogue and digital servo applications.
2. Small precision electro-mechanical mechanisms.
3. Precision mechanical engineering.
4. Hydraulics.

We feel we can offer Engineers an absorbing technical environment and the assurance that real ability is very quickly recognised and adequately rewarded. Engineers who would like to discuss these opportunities with the Engineering Manager are invited to write, giving concise details of their experience, qualifications and present salary, to :

The Personnel Manager,
Sperry Gyroscope Co., Ltd.,
Great West Road,
Brentford, Middx.

E5463 A

ATOMIC ENERGY AUTHORITY WINFRITH

A PROFESSIONAL ENGINEER

is required to assist the Reactor Maintenance Engineer in the prevention, analysis and rectification of electronic instrument failures, and to assume general responsibility for training reactor maintenance personnel.

Applicants should be Corporate Members of a Senior Engineering Institution, or have equivalent qualifications, preferably in the electronic or light electrical fields. Possession of a Degree in this field would be an advantage. The main requirement is the ability to establish cause from effects and generally diagnose and critically analyse faults as they arise.

Salary £845 (at age 25) to £1315 p.a.

Housing, superannuation scheme, generous leave allowance and good working conditions.

Send POSTCARD for application form and details to : Personnel Branch (W.97/25) U.K.A.E.A., A.E.E., Winfrith, Dorchester, Dorset.

E5441 A

SITUATIONS VACANT

HEINZ

Leaders in the expanding Food Processing Industry announce a Head Office vacancy :—

MECHANICAL ENGINEER

Having a record of practicaf experience and with A.M.I.Mech.E. qualification or equivalent. To be responsible to the Manager of Engineering for the installation of equipment and services in the Company's Factories and Warehouses. The position will require knowledge of Factory installations, services distribution and modern steam-raising plant. Accustomed to working with consultants. Preferred ages 30–35.

Applications should be made in writing to the Personnel Manager, H. J. Heinz Company, Limited, Harlesden, London, N.W.10.

E5436 A

PROJECT MANAGER

Chemical or Mechanical Engineer, with University Degree or equivalent, age 30–40, required to assume duties and responsibilities of Project Manager which requires technical and managerial ability on complete process plants for the chemical, gas and steel industries. Candidates should have minimum of 3 years' experience as Project Engineer in the chemical plant field. Experience in low-temperature engineering desirable, but not essential. This is an outstanding opportunity for the right man seeking senior engineering position.

PROJECT ENGINEER

Chemical or Mechanical Engineer of A.M.I.Mech.E. or A.M.I.Chem.E. standard, age 25–40, required for low-temperature process plants for the chemical, gas and steel industries. Candidates should have project engineering experience in the chemical engineering field.

AIR PRODUCTS (GREAT BRITAIN), LTD., is a rapidly expanding company engaged in the engineering, manufacturing and erection of low-temperature process equipment. Successful applicants have excellent opportunity for progressive advancement. Pension and life assurance scheme.

Write, Personnel Manager,
Air Products (Great Britain), Ltd.,
St. Giles House, 49/50, Poland Street,
London, W.1. E5518 A

SHELL

SHELL CHEMICAL COMPANY LIMITED

require a

WORKSHOPS ENGINEER

at their

CARRINGTON WORKS near MANCHESTER

Applicants should be in age range 32–40 years with A.M.I.Mech.E. Workshops experience is necessary, preferably in manufacture or servicing of chemical plant equipment.

Salary according to qualifications and experience. Attractive pension scheme.

Applications with full details to :
Shell Chemical Company, Limited,
Staff Department/M5,
Clements House,
14/18, Gresham Street,
London, E.C.2.

E5372 A

MECHANICAL ENGINEERING

and

PLANT LAYOUT DRAUGHTSMAN

required, 25–35 years of age, with good engineering background. Experience in general cable-making machinery detailing and/or cable factory plant and services layout, whilst not being essential, would be an advantage. Five-day week. Salary A.E.S.D. plus, according to qualifications and experience.—Write, stating age, experience, &c., to the Personnel Officer, British Insulated Callender's Cables, Ltd., Leigh, Lancs.

E5483 A

SITUATIONS WANTED

CAPABLE, ENERGETIC ENGINEER, A.M.I. Mech.E., A.F.R.Ae.S. (38), seeks post of Chief Engineer or similar. Experience of research, design, development in aircraft, general engineering and hydraulic fields, with good knowledge of production and assembly of precision components and assemblies. Executive positions held for 11 years.—BOX No. E2357, "The Engineer." B

ELECTRICAL ENGINEER (H.N.C. Diploma) seeks post in England as "Student Trainee."—Offers to BOX No. P 59170 Z, Publicitas, Zurich I. E5493 B

GENERAL WORKS MANAGER/GENERAL MANAGER (56), wide experience medium/heavy general engineering. Ferrous and non-ferrous foundry, machining, laboratory, fabricating, modern methods production, planning, administration. 24 years' executive. Apprentice and technical college trained. M.I.Brit.F., M.I. Welding.—BOX No. E2359, "The Engineer." B

MACHINE SHOP SUPERINTENDENT (45 years) desires change. 19 years' full control of shops and production units. Experienced in batch and one-off production. Heavy and light components. Progressive position required with salary commensurate with ability. Available May 25th.—BOX No. E2361, "The Engineer." B

PATENTS

THE PROPRIETOR OF BRITISH PATENT NO. 723,101 for "STEAM-AND-WATER COLLECTORS FOR STEAM-GENERATORS," desires to enter into negotiations with a firm or firms for the Sale of the Patent or for the grant of Licences thereunder.—Further particulars may be obtained from Marks & Clerk, 57 and 58, Lincoln's Inn Fields, London, W.C.2. E5449 H

FOR HIRE

LATTICE STEEL. Erection Masts (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1. ('Phone, SLOane 5259). E103 K

SUB-CONTRACTING

CASTINGS.—We can save your porous castings, ferrous or non-ferrous, by an approved impregnation process ; sample castings treated ; A.I.D. approved. —Recupero, Ltd., 66, South Harrow Viaduct, Harrow, Middlesex ('Phone Byron 1178). E109 MW

KELLERING AND CAM PROFILING capacity up to 8ft. by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone : Knottingley 2743/4). E116 MW

DRAWING OFFICE.—CAPACITY FOR DESIGN, DETAILING AND TRACING. Specialists in Technical Illustrating. Old-established firm who do work throughout the British Isles. Associated Engineering Products, Arcade Chambers, Eltham, S.E.9 (Telephone : ELT 2233/4). E2360 MW

BUSINESS OPPORTUNITIES

HOUSE JOURNALS WITH THE PROFESSIONAL TOUCH and at realistic prices ! We can provide 4-page works newspapers (11¼in. by 8¼in.) and 16-page magazines (8¼in. by 5¼in.), with vitality and imagination, containing up to 50 per cent. articles and features (provided free)—the remaining space for company news and activities ; 4-page newspapers from £12 10s. for 500 copies, additional 500s £4 10s. ; 16-page magazines from £22 10s. for 500 copies, additional 500s £8 10s. Exclusive rights in your particular industry in your area. Beautifully printed on art paper by the new photo-litho process, which requires NO BLOCKS whatever and cuts your costs. Special commissions undertaken.—Specimens from "House Journals," BOX No. E5435, "The Engineer." O

MACHINERY Etc. WANTED

WANTED

Battery-operated, 2ft. gauge, 6/7-ton Locomotive. Details to :
The General Works Manager,
BRITISH INDUSTRIAL SAND, LTD.,
Holmethorpe, Redhill, Surrey.
E5413 F

BUSINESSES & PREMISES

TO LET. FACTORY BUILDING prominent position off City Road and convenient Undergrounds. Very light open floors measuring 15,000 square feet nett. Services include oil-fired central heating- ½-ton electric goods/passenger lift. Large parking and loading yard. Rent, £5750 p.a. Exclusive.—Apply Estate Manager, 18 Upper Brook Street, W.1. E5502 L

FOR SALE

VALES PLANT REGISTER LIMITED

OFFER FOR IMMEDIATE SALE

CRANES

NEALS 1-ton "D" MOBILE, 30ft. Swan-neck, Ruston engine, pneumatics. £750.
NEALS 2-ton NM MOBILE, 30ft. jib, Crawlers, Ruston engine. £1400.
JONES "Super 20" MOBILE, 24ft. jib, Lister Diesel, solids. £400.
JONES "Super 22" MOBILE, 16ft. Cantilever, pneumatics. £950.
NEALS "NM" 3-ton MOBILE, 30ft. Lattice, Ruston engine, pneumatics. £2950.
ANDERSON GRICE 3-ton Electric DERRICK, 120ft. jib, S.L.I. £1500.
JONES KL44 4-ton MOBILE, 50ft. jib, Ruston Diesel, pneumatics, 1957. £2950.
COLES THORNEYCROFT 5-ton LORRY MOUNTED Mk. 7 Series 7, 30ft. jib, Rope derricking. £2500.
NEALS 4-6-ton "QM" MOBILE, 26ft. jib, Ruston engine, Pneumatics. £2675.
COLES S.88 6-ton MOBILE 21ft. 9in. Cantilever, Solids, Perkins engine. £2250.
COLES 6-ton LORRY MOUNTED, Rope derricking, 17-35ft. jib. £3300.
BUTTERS 7-ton 2-motor ELECTRIC DERRICK, 120ft. jib. £2975.
MICHIGAN TMCT 16 7½-ton LORRY MOUNTED Crowd Shovel, Dragline and 30ft. jib, Buda Diesel, Pneumatics. £3300.
HENDERSON 10-ton Steam DERRICK, 120ft. jib, Bogies available.
ANDERSON GRICE 10-ton Single Motor ELECTRIC DERRICK, 120ft. jib. £4150.
COLES 10-ton Fully MOBILE, 40ft. Jib, Perkins engine, Pneumatics. £5350.
COLES 12½-ton Fully MOBILE, 80ft. Jib. £4950.
FOR A COMPREHENSIVE LIST OF PLANT FOR SALE AND HIRE—SEND FOR VALES FREE MONTHLY PLANT REGISTER.

Further details,
14, LOWER GROSVENOR PLACE,
LONDON, S.W.1.
Telephone : VICtoria 7531, 3501, 8080, 9886 (15 lines). E107 G

600

SPECIAL OFFER

HEAVY-DUTY FORK LIFT TRUCKS

Capacity	18,000 lb. at 33in. centres	15,000 lb. at 24in. centres
Make	Shelvoke and Drewry	Ransomes and Rapier
Lift	17ft. 6in.	17ft. 6in.
Engine	Perkins P.6	Perkins P.6
New	1956	1956
Tyres	Pneumatic	Pneumatic

Also available, Second-hand FORK LIFT TRUCKS of 4000 lb. capacity, fitted with diesel engines.

GEORGE COHEN,

SONS AND CO. LTD.
600, WOOD LANE, LONDON, W.12.
E202 G

FOR SALE

Plate Straightening Rolls, capacity 8ft. by 1¼in., 5 roll with 30 h.p. 400/3/50 motor and reversing controller.
Plate Bending Rolls, capacity 30ft. by 1¼in. Fully motorised 400/3/50. Makers "Bennie."
Both in first class condition available in 4–6 weeks. Apply :

G. E. SIMM (MACHINERY), LIMITED,
27, Broomgrove Road, Sheffield, 10.
Tel. : 64436 E5481 G

MASSEY 5 CWT. PNEUMATIC POWER HAMMERS, overhanging type with slides ; longest stroke 21in., number of automatic blows per minute 140, anvil set at an angle to accommodate long bars, arranged direct motor drive, complete with anvil, centre to back 18in., size of bar worked 6in. square. Weight about 6½ tons.—F. J. Edwards, Limited, 359, Euston Road, London, N.W.1, or 41, Water Street, Birmingham, 3. E5513 G

FOR SALE

FRED WATKINS (ENGINEERING), LTD.

STEAM BOILERS.—Cochrane Vertical (New), 8ft. 6in., 8ft., 7ft. 6in. 7ft. and 6ft. in dia., 100/150 lb. w.p. ; reconditioned 8ft. 6in. down to 3ft. dia. ; Economic 4ft. to 11ft. 6in. dia., including new 7ft. and 8ft. dia., 150, 180 and 200 lb. w.p. ; 300 reconditioned Vertical Crosstube, all sizes.
AIR COMPRESSORS.—Two Bellis & Morcom 2500 c.f.m., 100 p.s.i., 550 h.p. motors ; also Broomwade 500, 400, 300, 200 and 130 c.f.m., all motorised ; and several others of various makes and capacities.
200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.
ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 100 h.p.
MOBILE ROAD CRANES.—10-ton Lorain lorry mounted, 30ft.–70ft. extendible jib ; 10-ton 33 R.B. track mounted 40ft. jib ; 8½-ton Ransomes Petrol/Electric, 21ft. jib ; 6-ton Coles Diesel/Electric, pneumatics, new 1948 (7) ; 6-ton Coles Diesel/Electric, solids ; 4-ton Coles Diesel/Electric, solids, 1945 ; 4-ton Jones KL44, diesel, 1950 ; 3-ton Jones "Super 40" diesel, pneumatics (3) ; 2-ton Jones "Super 20" diesel, pneumatics.
OVERHEAD CRANES.—60-ton Clyde, 40ft. span, 400/3/50, "Goliath" ; 40-ton Babcock, 40ft. span, 400/3/50, "Goliath" ; 30/5-ton Adamson, 42ft. 3in. span, 400/3/50 ; 20/6-ton Vaughan, 42ft. 3in. span, cab type (6) ; 20-ton King, 42ft. 3in. span, 400/3/50 ; 15-ton Morris, 35ft. span, hand operated ; 10-ton Morris, 45ft. span, 36ft. lift ; 10-ton Morris "Goliath," 40ft. span, 400/3/50 ; 10-ton Vaughan, 23ft. 6in. span, 400/3/50 ; 10-ton Vaughan, 21ft. span, 44ft. lift ; 7½-ton Wharton, 25ft. span, 400/3/50 ; 5-ton Henderson, 24ft. 7in. span, 1946 ; 5-ton Morris, 58ft. span, hand operated ; 5-ton Royce, 2-motor crab, 440/3/50 ; 5-ton King, 29ft. 3in. span, power hoist, hand travel ; 5-ton Morris, 28ft. 6in. span, power hoist, hand travel ; 4-ton Morris, 19ft. span, 220V., d.c. (3) ; 3-ton Adamson, 48ft. span, 400/3/50 ; 2-ton Adamson, 34ft. span, 400/3/50 (2) ; 2-ton Morris, 18ft. span ; 2-ton Vaughan, 27ft. 6in. span, 2-motor ; majority of the above are unused.
DERRICK CRANES.—7-ton Rushworth hand, 30ft. jib ; 5-ton Wilson Electric, 70ft. jib ; 1½-ton Anderson Grice, hand, 40ft. jib.
RAIL CRANES.—18-ton Brownhoist, steam, 50ft. jib ; 10-ton Coles steam, 40ft. jib ; 8-ton Wilson steam, 35ft. jib ; 5-ton Smith, 50ft. jib (2) ; 5-ton Cowans Sheldon, 50ft. jib.
LOCOS.—Fowler diesel, 150 h.p. (2) ; Ruston diesel, 80/88 h.p., new 1942 ; Bagnall 14in. by 22in., two oil fired, one coal ; Peckett steam, 7in. by 12in., 1941 ; also 3 miles track, 24in. gauge, Bogies, Turnouts, &c.
STEEL PIPING.—50,000ft., 2in. Galvanised, new ; 60,000ft., 3in. black, new ; 5000ft., 8in. seamless ; 1000ft., 12in. seamless ; 500ft., 14in. seamless ; 400ft., 18in. riveted ; 280ft., 21in. o.d. welded flanged ; 3800ft., 21in. seamless flanged ; 500ft., 24in. riveted ; 1450ft., 27in. o.d. welded flanged ; 216ft., 48in. riveted ; 216ft., 60in. riveted.
CAST IRON PIPES.—Large stocks all sizes up to 24in. flanged and s.s. Immediate delivery.
VALVES.—Exceptional Surplus Ministry Lot New Stainless Acid Cocks and Valves, over 5000, immediate delivery, below makers' prices. Large stock all sizes, Parallel Slide Sluices, Gunmetal, Reducing and Check Valves. List on request.
STORAGE TANKS.—300 cylindrical and rectangular up to 12,000 gallons, for oil and petrol, also sectional steel and cast iron up to 50,000 gallons.
MACHINE TOOLS.—Scriven Plate Bending Rolls, 14ft. by ¼in. ; Robertson Straightening Rolls, 8ft. 6in. by ¼in. ; Berry Bending Rolls, 7ft. by ¼in. ; Tangye 200-ton Hydraulic Vertical Straightening Press, 15ft. by 3ft. table ; Herbert 3ND Miller, 61in. by 15in. table ; Pels Punch and Shears, ¾in. capacity ; nine new 2 cwt. and 1 cwt. Pneumatic Hammers ; Bliss 14T Tapering Press ; Bonn Hydraulic Tube Bender up to 20ft. by 4in. bore ; Bigwood geared Bending and Straightening Machine up to 12in. by 6in. R.S. Joists ; two 40kVA. Spot Welding Machines ; Wire Drawing Machine, 3 die up to ¼in. copper ; 50kW. Electric Furnace, 1000 deg. Cent., chamber 54in. by 30in. by 21in.

SLING ENGINEERING WORKS
COLEFORD, GLOS.
'Phone : Coleford 2271/2. E106 G

FOR SALE

One "BARCRO" Camera Projection Unit. Camera D.E. size and special Zeiss lens. Complete with processing trays, film drying cabinet, film hanger racks, 2 Flat Bed Dryers D.E. size. One Flat Bed Glazer and Dryer and miscellaneous equipment. £250 complete. Will sell camera as separate item. Apply to GILBERT GILKES AND GORDON, LTD., Engineers, Kendal, Westmorland. E5491 G

600

SPECIAL OFFER

Two only virtually unused 3-motor ELECTRIC OVERHEAD TRAVELLING CRANES, arranged for floor control, suitable for supply of 400 volts, 3-phase, 50 cycles. New 1955. Capacity 7 tons, 48ft. 0in. span, lift 30ft.
These cranes have only seen a few months' use and are equal to new.

GEORGE COHEN,

SONS AND CO. LTD.
600, WOOD LANE, LONDON, W.12.
E204 G

BULLARD 36IN. VERTICAL BORER

Swing 38in., 12 speeds 12–200 r.p.m., with side head, M.D. 440/3/50.

H. BELL (MACHINE TOOLS), LTD.,
WALTER STREET, LEEDS, 4.
Tel.: 63-7398.
E105 G

THE COMMISSIONERS FOR THE PORT OF CALCUTTA

The Commissioners for the Port of Calcutta wish to PURCHASE or CHARTER a TWIN-SCREW SAND SUCTION HOPPER DREDGER for service on the River Hooghly, with the following characteristics :—

1. Dredging depth 45–55ft.
2. Pumping capacity not less than 3000 tons of solids per hour at 20 per cent. concentration.
3. Draught, if possible, not to exceed 17ft. loaded.
4. Hopper capacity between 2500 and 4000 tons.
5. Service speed not less than 9½ knots and preferably higher.
6. The dredger to be fitted with a bow or centre well, preferably the former. Stern well will not be considered.
7. Dumping preferably through Lister valves. If hopper doors are fitted, the increase in draught with the doors open to be stated.
8. The dredger to be steam driven, preferably with oil-fired boilers.

If a suitable dredger is available for charter for a period of not less than two years, the Commissioners would consider Diesel-Electric propulsion if suitable qualified engineers were available with the ship.

Offers not conforming to the above specifications will also be considered if necessary modifications can be carried out within reasonable limits without affecting its performance to suit our requirements.

A Committee of Experts will examine the dredgers selected and the seller should extend them all facilities.

Particulars of the craft should be forwarded to the Deputy Conservator, Commissioners for the Port of Calcutta, 15, Strand Road, Calcutta, 1, and also to Messrs. Rendel, Palmer and Tritton, 125, Victoria Street, Westminster, London, S.W.1.

C. J. MOHAN,
Deputy Conservator.
Calcutta, dated the 26th February, 1959. E5318 F

Classified Advts. continued on page 140

FOR SALE

HYDRAULIC PRESSES

500-ton cap. FIELDING & PLATT, 4-column downstroke, 24in. stroke, ram 12in. dia., Fraser OLS 30 Hydraulic Pumps, 3200 lbs. p.s.i. working pressure.

200-ton FAWCETT PRESTON 4-column downstroke, ram 20in. dia., stroke 24in., 26¾in. between columns.

190-ton SHAW 4-column Upstroke PLUNGER PRESS main ram 19in. dia. by 17in. stroke, downstroke plunger ram 8in. dia., 36in. between columns.

100-ton cap. FIELDING & PLATT, 4-column downstroke, ram 9in. dia., stroke 4ft., Fraser type OLS 30 Pump, 3200 lbs. p.s.i. working pressure.

THOS. W. WARD LTD.

ALBION WORKS - - - - - - SHEFFIELD
'Phone : 26311 'Grams : "Forward."
E216 G

FOR SALE

CHURCHILL-REDMAN 24in. Surfacing, Boring and Screwcutting TURRET LATHE ; swing 38in. by 19in. in gap.

F. J. EDWARDS LTD.,

359–361, EUSTON ROAD, LONDON, N.W.1.
EUSton 4681 and 3771.

E5434 G

FOR SALE

Eleven Mason Duplex Major Drafting Stands complete with D.E. boards, parallel edge movement, &c. The boards are in good condition, having been covered with plastic backing. No pin holes. £20 each.

Two Mason Duplex Maior as above but having Antiquarian board. £25 each.—Apply to GILBERT GILKES AND GORDON, LTD., Engineers, Kendal, Westmorland. E5490 G

FOR SALE.—125kVA. RUSTON/MATHER & PLATT, 365/440 volts, 3 ph., 50 c. Diesel Alternator Set. Type 3 V.E.A. cold-starting engine, air-starting. Stand-by set, little used. Bargain before removal. —JOSEPH PUGSLEY & SONS, LTD., Bristol, 5. Tel.: Bristol 56037. E5389 G

FOR SALE

600

COMPRESSOR SETS

2500 c.f.m. BELLISS and MORCOM, 100 p.s.i., with 550 h.p. Crompton Parkinson motor, 3·3kV. or 400/440/3/50.

410 c.f.m., 120 p.s.i., BROWETT LINDLEY with Laurence Scott and Electromotors 95 h.p. slipring motor, 400/3/50.

TWO 330 c.f.m. BROOM and WADE, 100 p.s.i. with Brook 75 h.p. slipring motor, 400/3/50.

Many others in stock would welcome your inquiries.

GEORGE COHEN,

SONS AND CO. LTD.
WOOD LANE, LONDON, W.12.
Tel.: Shepherds Bush 2070 ; and
STANNINGLEY, Nr. LEEDS.
Tel.: Pudsey 2241. E206 G

FOR SALE

RAILWAY TURNTABLE
For Sale.—Mundt type standard gauge turntable, 65ft. long, carrying capacity 150 tons approx.

WATER CRANE
3000 gallon water crane.

TURNOUTS
Twenty 1 in 8 turnouts in 75 lb. F.B. rail ; interchangeable to suit L.H. or R.H.

All these items are in excellent condition.

Apply : EAGRE CONSTRUCTION CO., LTD., East Common Lane, Scunthorpe, Lincs. ('Phone : 4513). E150 G

FOR SALE

One Lang Junior Lathe, 12in. Chuck with screw cutting gear.

One Pels Cropping Machine for rounds, angles and flats.

Two Rice Hydraulic Pumps, three cylinder 12in. Stroke with electrics, one d.c., one a.c.

The above can be seen under working conditions. —BOX No. E5475, "The Engineer." G

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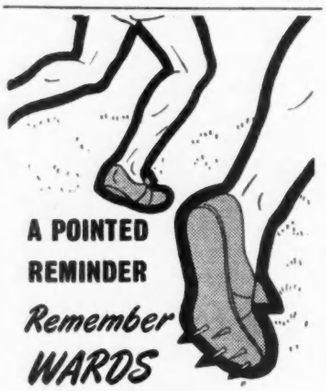

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April 28–30	**Machine tools and miscellaneous stores,** including :	M.O.S. Storage Depot, **Royal Arsenal, Woolwich, S.E.18.**	**FULLER, HORSEY, SONS & CASSELL** (Dept. L), 10, Lloyd's Avenue, E.C.3. (Tel.: Royal 4861.)
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May 6–7	**Miscellaneous stores,** including large quantity of vehicle tyres.	M.O.S. Storage Depot, **Rotherwas, Hereford.**	**RUSSELL, BALDWIN & BRIGHT, LTD.** (Dept. L), 20, King Street, Hereford. (Tel.: 4366.)
May 12	**Miscellaneous stores.**	M.O.S. Storage Depot, **Ruddington, Notts.**	**WALKER, WALTON & HANSON** (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272.)
May 22	**Miscellaneous stores,** including hand tools, etc.	General Stores Sub Depot, **Longtown, Nr. Carlisle.** (Sale at County Hall, Carlisle.)	**HARRISON & HETHERINGTON, LTD.** (Dept. L), Botchergate, Carlisle. (Tel.: 26292/3.)
May 26	**Vehicles and miscellaneous stores.**	M.O.S. Storage Depot, **Bowhouse, Hurlford, Nr. Kilmarnock.**	**DIXON & WALLACE, LTD.** (Dept. L), Bank Buildings, Graham Square, Glasgow, E.1. (Tel.: Bridgeton 2447.)

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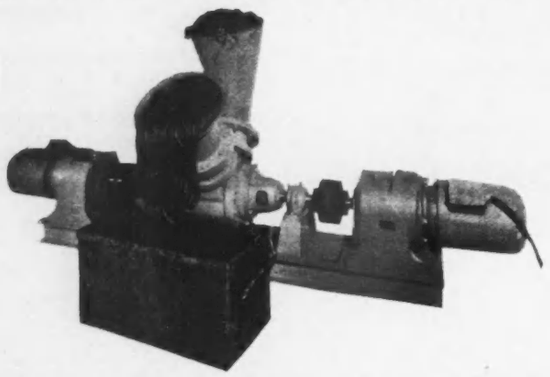

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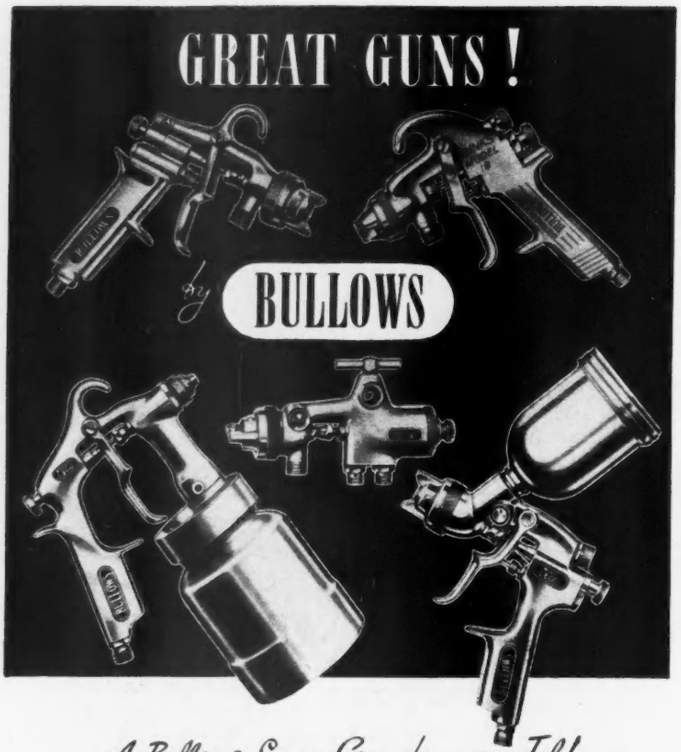

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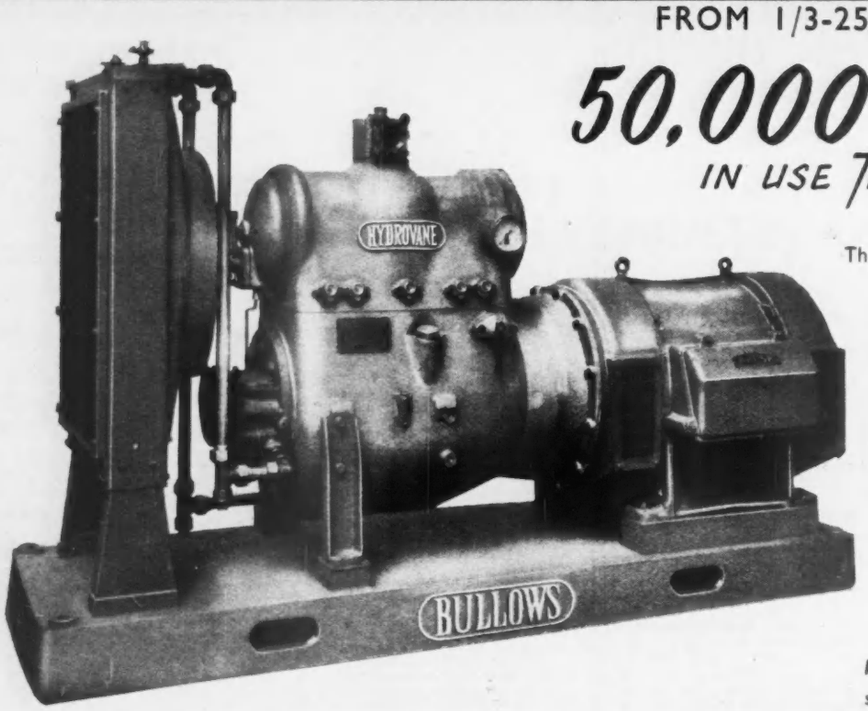

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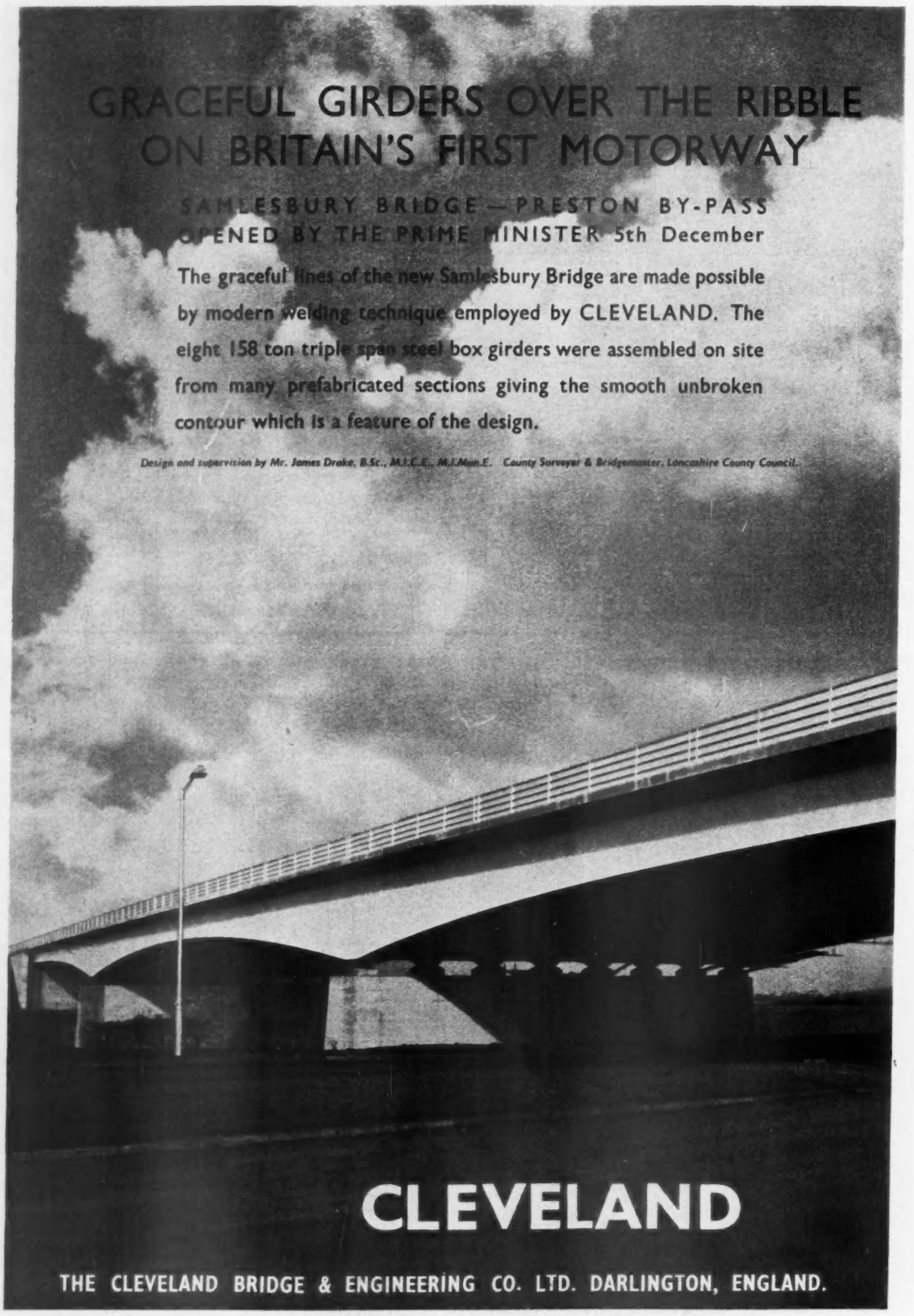
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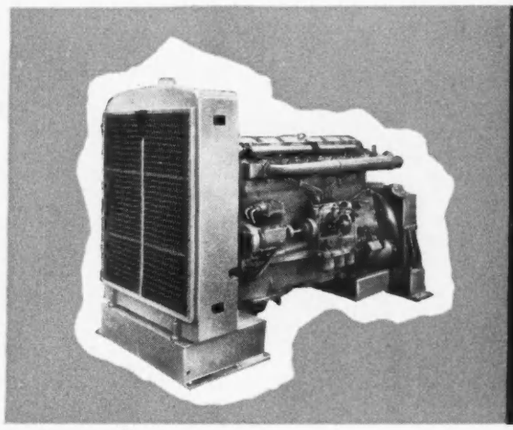

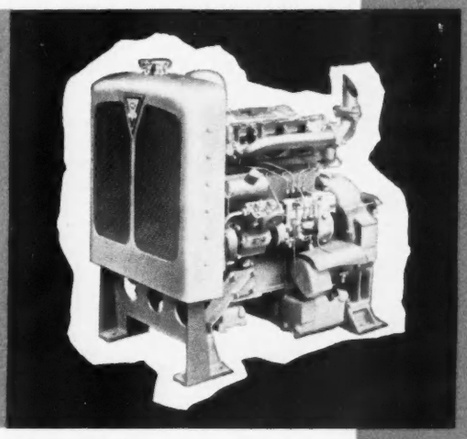

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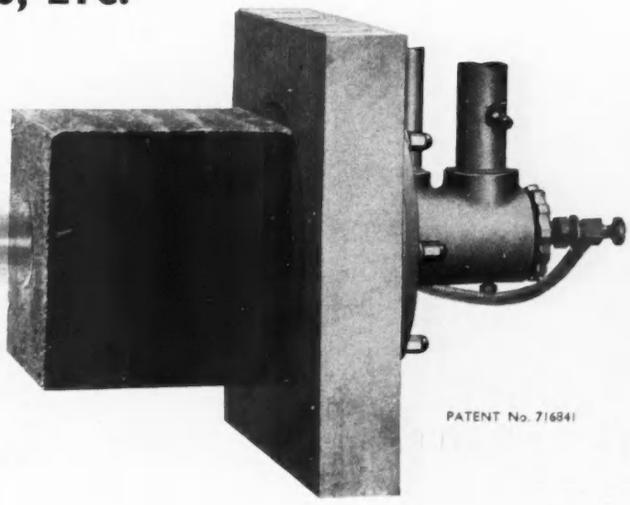

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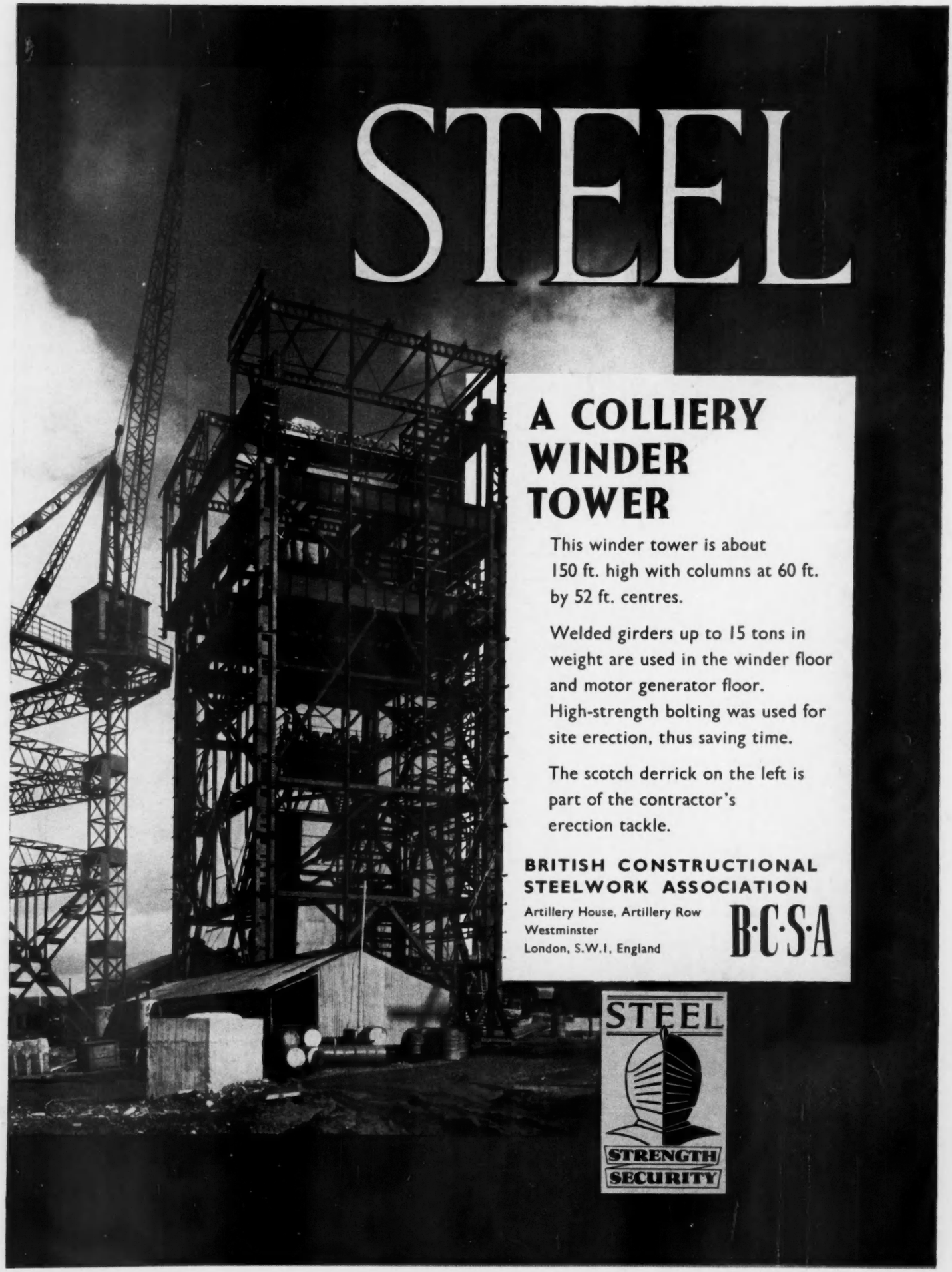

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A COLLIERY WINDER TOWER

This winder tower is about 150 ft. high with columns at 60 ft. by 52 ft. centres.

Welded girders up to 15 tons in weight are used in the winder floor and motor generator floor. High-strength bolting was used for site erection, thus saving time.

The scotch derrick on the left is part of the contractor's erection tackle.

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